OCS COMPUTER SYSTEMS PLANNING REPORT

1 June 1965

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DIRECTORATE OF SCIENCE AND TECHNOLOGY

OFFICE OF COMPUTER SERVICES

CONFIDENTIAL

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DD/S&T Computing System
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Chapter 1.

STATEMENT OF PROBLEM, OBJECTIVES, AND SUMMARY CONCLUSIONS

1.1. PROBLEM

The Office of Computer Services (OCS) was established in 1963 and now provides support to the four Agency Directorates. At the present time OCS operates five separate independent computer systems supplied by two different computer manufacturers. In late 1965 a sixth system will be added of yet another type. The total staff to program and operate this equipment now numbers 25X1A [redacted] This total staff is occupied in the management, supervision, analysis, programming, coding, checkout, data preparation, operation, and administrative support for this computer complex.

The aggregate new purchase price of the presently installed equipment is approximately 25X1A [redacted] The programmers are provided with 19 different programming languages/ operating systems. The training program is formidable. The program maintenance and documentation problems are staggering. The programming experience interchange and reinforcement is minimal. Most line programmers are unable to maintain current competency in more than one of these programming languages at

time. Thus, management is severely inhibited from assigning programmers to projects in response to the urgent needs of the Agency since an "unlearning" and retraining period is required before a man's experience can be transported across machine lines.

Similar to the case mentioned above, program interchangeability is likewise difficult. Although a program may be written in FORTRAN, it is very difficult to operate that program on the 1410 if the program was originally intended for the 7090. The FORTRAN expressions for these two machines are related but not identical; and the two operating systems are extremely different. The commonality between the two computers is limited to their tape drives and their point of manufacture. Both the 1410 and 7090 use the 1401 computer for large volume input/output processing. Thus, if a backlog overwhelms the 7090, the 1410 is of slight use in reducing it. An even worse condition exists when a peak load strikes the RCA computers because the IBM equipment is of no value whatsoever in reducing this peak to satisfy the service requirements.

The Computer Center is operated three shifts a day,

including most weekends. During the day shift the interplay between operations and the programmers and customers is the greatest when these "users" are bringing work to the center to be processed or are picking up work that has been completed. At that time operations personnel and "users" get involved in discussing problems encountered during processing, priorities, status of jobs, etc. The second and third shifts handle the larger production jobs and these shifts manage to finish most of the priority work each day. The weekends are used for severe backlogs or special operations requirements. Chapters 2, 3, and 4 provide additional details on how the present computers are utilized, the on-going jobs, and anticipated increases in workload by project, respectively.

According to best projections, our workload will quadruple in the next five years, even without any additional pressures toward centralization from management or the Bureau of the Budget. To attempt handling this increased workload with additional equipment of the present types and manufacturers would be grossly expensive and shortsighted. To handle this additional workload with our personnel committed to so many different computer systems would be patently impossible. It is not feasible to obtain the required number of billets,

to staff and train sufficient personnel, and to operate such multiple systems efficiently. To manage such a diverse work force would be most difficult, if not impossible, over the long run.

1.2. REQUIREMENT

From a study of the applications, both present and contemplated, a series of requirements emerged. First, the Agency requires a wide variety of storage devices of several types depending on the volume of information to be stored and the necessary response time to programmed commands. In addition, the predicted workload will involve situations where data files will be held on-line in magnetic form so that they may be interrogated remotely from consoles within the building. The response to these queries will be printed as directed by the interrogator, provided: (a) he has properly identified himself, (b) has previously established his authorization to access the information he desires, and (c) the electrical connections to the console are appropriately secure.

The present computer equipment can only be operated in the "batch" mode. Requests for information are now transported to the Computer Center where they are key punched and

manually scheduled. As appropriate to their priority (and the Center's work-load at the time of scheduling), runs are made and output is obtained. Such outputs usually take the form of magnetic tape which subsequently must be scheduled and printed. After hard copy is thus obtained, the necessary control and bookkeeping measures are satisfied, and it is finally transported back to the user. While this cycle can be completed in an hour or less for high priority small volume requirements, the dislocation to the remaining workload in the Center is such that 24 to 36 hours are frequently required for recovery. As the requirements increase for reduced turnaround time on request, such schedules will become completely untenable. Clearly a superior way must be found to satisfy the needs of the Agency.

1.3. OBJECTIVES

In order for the OCS to meet the expanding computer support needs of the Agency, certain objectives become clear.

a. Select <u>one set</u> of hardware and software so that management problems in training, personnel assignments, documentation, etc., are minimized.

b. Provide equipment with <u>large</u> capability for growth without reprogramming as hardware capabilities are expanded.

c. Provide equipment with the ability to utilize remote consoles for interrogation of files, programming, debugging, program execution, etc.

d. Provide equipment (including foreseeable expansion) that would fit inside the present Computer Center area.

e. Provide the best software in terms of programmer and operator efficiency.

f. Provide equipment that will assure the Agency of computer capability on a 24-hour-a-day, 7-days-a-week basis.

I.4. EQUIPMENT SELECTION

Starting in early 1965, the OCS Technical Staff conducted evaluations of candidate computer systems. The capabilities of equipment (and software) which is available from the leading manufacturers were measured against the Agency's requirements. Major consideration was given to the systems offered by CDC, G.E., Honeywell, IBM, Remington Rand, and RCA. (A detailed technical evaluation paper is referenced in Chapter 11). Some of these vendors were eliminated simply because they did not offer the complete range of equipment (storage devices, display units, etc.) required to fulfill Agency needs. Others were eliminated

because their software (a most critical element) was not sufficiently developed and documented to allow adequate evaluation. And some, being more competitive, were eliminated on the basis ofa price-performance index. Finally, two computer systems emerged for consideration in our most detailed evaluation: the GE 636 and the IBM 360/67. The IBM 360/67 was selected for the following principal reasons:

a. Unit-of-work processing cost is lowest on the 360/67.

b. The IBM 360/67 is a variable word-byte oriented system --- ideal for the OCS job mix of 75% data processing and 25% scientific computing.

c. While the effectiveness of both systems hinges on the development of extensive new hardware and software, there is much stronger ground for confidence in IBM's ability to produce. (The 636 is GE's first venture in a really large scale computer system).

d. IBM offers a much larger variety of random access devices.

e. IBM technology is more advanced, i.e., the 360 equipment is micro-electronic while the 636 is limited to earlier type transistorized components.

f. IBM has already documented more advanced software than GE.

The OCS Task Team, which concentrated on this problem, concluded that the IBM 360 offers sufficient capability and breadth to satisfy Agency requirements now and in the foreseeable future. The conversion task will be less arduous than if some other manufacturer had been chosen. Finally, the IBM equipment will fulfill Agency needs, both present and future, with a minimum of expenditures both for equipment and personnel.

1.5. PURCHASE VERSUS RENTAL

In considering the acquisition of new computing equipment, the question of purchase versus rental is always raised by Agency management, BOB and others. From the viewpoint of OCS management, rental is generally preferred and we believe justified. The only advantage of purchase is the possibility of economic savings that might be realized by the Government as a whole. Actually, it is a severe handicap to a component charged with reacting to the broad dynamic requirements of intelligence collection and production problems.

An OCS paper on the merits of purchase vs. rent of the

proposed hardware is referenced in Chapter 11. It notes how difficult it is to predict what components are going to survive for 4-5 years (the approximate break-even point) in the rapidly developing world of micro electronics. At this time, it can only be recommended that all of the proposed hardware be rented. This problem will remain under most serious surveillance by OCS as it progresses with the evolution of its advanced systems.

1.6. THE PROPOSED PLAN

A progressive schedule of equipment installations has been devised which will provide for staff retraining and continuing progress with a minimum dislocation of current operations. The final basic expansible system will be installed in the summer of 1967 and it is detailed in Chapter 5. It consists of a Model 67 Computer with twin Central Processing Units from the IBM System 360 family. These CPU's will be inter-connected in such a manner that the system will recover rapidly from all single hardware failures and may recover rapidly from many complex hardware malfunctions. (This is a "fail-soft" feature of the new system). Therefore, the availability of the system will approach 100% so that the automated files will be available for query and response 24-hours-a-day, seven-days-a-week.

It is envisioned that the proposed system be operated in the following way. The majority of the program preparation will be done in the present traditional manner. However, run requests will be fed directly to the computer for automatic scheduling (rather than manual scheduling, as at present), the computer will read new information into its memory, interpret control cards describing the job and its priorities, perform the required scheduling, and store the job (both program and data) on a direct access storage device. When the job in question has risen to the top of the queue so that it is scheduled for execution, the software required will be fetched from disk storage and the job will be executed.

If an interrogation is received from a remote location during this processing period, the processing will pause temporarily while the query is interpreted and its response is being prepared. The system currently contemplated will be able to handle console activity from several dozen consoles without appreciably slowing down the processing of the background job which is in progress.

If the query from the console requires a significant amount of processing before the response is available, then

a new task will be established, automatically scheduled, entered into the queue for processing at the appropriate point, and executed in due course. Under this condition there will, of course, be an indeterminate delay at the console due to the queue length and processing required.

The system, as contemplated, will allow programmers to prepare and check out new work in the "background". At least one of the two processing systems will be constantly available (within the limitations mentioned earlier) to service queries from the remote stations and to enter jobs as appropriate into the queue. Any additional time available on one processor will be used for executing background jobs. Normally one of the dual computers will be solely dedicated to performing background production work. In the event of a malfunction on either system, the surviving processor will immediately assume the console load while the throughput of background is reduced until the machine that failed is repaired. This is a limited form of time-sharing which seems to be well-suited to the needs of the Agency and the abilities of its programming staff. At some future date, as the programming staff becomes proficient in the mode of operation outlined above, and as the current developments in time-sharing mature, additional capabilities will be

provided. These capabilities may encompass on-line interaction for data preparation and editing, reactive consoles to augment and assist the programmer in the preparation of new program modules, etc.

1.7. SUMMARY CONCLUSIONS

The plan outlined in this report fulfills the objectives stated above. It has incorporated into it all the latest hardware and software features. The throughput cost is the best available. It has outstanding growth possibilities without additional reprogramming. An almost unlimited number of consoles are feasible. Due to the duplication of key hardware, its off-the-air time should be nearly zero.

The implementation timing set forth in the plan is quite optomistic but an ambitious schedule is necessary in response to the problem faced by the Agency. It will require prompt reaction by OCS and Agency management when problems are encountered. It will require a determined, forceful push by all people involved in meeting their hardware, software dates.

Slippage in the proposed schedule is to be expected and may not be too damaging. Even if the proposed plan is slipped by some months OCS will still attain, early in the remote console era, a pre-eminent position to support the Agency

in its critical mission.

Unless a plan such as this is carried out, it will be impossible for OCS to provide the automatic data processing support that the Agency clearly needs.

Chapter 2

PRESENT SYSTEM ANALYSIS

2.1. HARDWARE

As of 1 June 1965 computer equipment installed in the CIA Computer Center consists of the RCA 501, RCA 301, IBM 7090, IBM 1410, IBM 1401, and related peripheral equipment such as a CalComp Digital Incremental Plotter, and a Digi-Data Paper Tape-to-Magnet Tape Converter. A small number of card processing machines and data preparation machines such as card punches and verifiers are also employed. Costs of these systems are detailed in the following system description.

2.1.1. Historical Perspective

In planning ahead for new computer equipment it is perhaps well to look back over the history which brought us to the present computer complex.

One of the first uses of automatic data processing equipment in the Agency was in the administrative and accounting fields. Applications in these areas are frequently referred to as "business applications" and they include such

applications as Payroll, and Accounting in support of Personnel, Supply, and Finance. From the very beginning of the Agency, these applications were performed on IBM punched card equipment. In October 1960, the RCA 501 computer was installed for these applications. The objectives in the installation of this equipment were to improve the speed, flexibility, and costs of processing "business applications". In the process of phasing in the RCA computer, substantial amounts of card processing equipment were released and card processing applications were switched to the computer.

Generally speaking, the computer reduced the number of operators but increased the number of people in planning activities, i.e., system analysis, design, and programming. While the speed of processing was significantly improved once a job was fully converted and checked out on the computer, more thorough requirements analysis and a longer planning period were needed for programming and job setup. Often the overall time spent on new jobs or applications was quite lengthy.

Mechanically, the RCA input/output equipment was less than satisfactory. The printer was serviced extensively but failed to provide "on register" print lines. The card

transcriber also appeared to be below normal standards of reliability. As a result the Agency ordered an IBM 1401 for input/output processing. Shortly before this installation was to take place, the announcement of the RCA 301 computer with IBM card reader punch and an improved printer resulted in its acquisition vice the IBM 1401. The compatibility of the RCA 301 with the installed RCA 501 and its lower costs were additional contributing factors to this decision. The RCA 501 and RCA 301 are used more than any other systems in the CIA Computer Center; their average usage is 565 hours per month and 490 hours per month respectively.

In January 1963 the IBM 1410 and IBM 1401 systems were installed. These systems provided the capability of editing, sorting, and listing large files of data. Intelligence files and special projects in the DD/I area which had not previously been considered feasible on EAM equipment provided the principal volume of work for these systems. Later, new "business applications" in the DD/S area began to add significantly to the workloads, a case in point being the Security Automated Name Check Activity (SANCA) project. Utilization of the IBM 1401 and IBM 1410 averages 440 hours and 547 hours per month, respectively.

In July 1963, the IBM 7090 was installed to fill the need for a large-scale scientific computing capability. One of the great benefits of this particular computer was the easy acquisition of many operational IBM 7090 programs developed by other users in the aerospace, intelligence, and scientific fields. Utilization of this system averages 500 hours per month.

2.1.2. Peripheral Equipment

The CalComp Digital Incremental Plotter System and the Digi-Data Paper Tape to Magnetic Tape Converter are representative of peripheral equipment purchased to provide a unique capability. The plotter has been used both for plotting telemetry data in analog form and for statistical graphs. The paper tape converter has been used primarily for project Electronic Printing of Intelligence Composition (EPIC) and for Foreign Missile Space Analysis Center (FMSAC) requirements.

2.1.3. Incompatibility

The problem of compatibility of data and computer hardware occurs between the RCA and IBM equipment. Magnetic tapes are not interchangeable between these systems and the only communication between these computers is through punched cards.

ILLEGIB

The CalComp Plotter and the Digi-Data tape converter are IBM compatible. In the near future an IBM compatible tape unit will be installed on the RCA equipment to facilitate communication between RCA and IBM systems. This will provide a means for eventual conversion of RCA data for processing on IBM equipment.

2.1.4. Equipment Installed June 1965

Five computer systems are installed and in operation as of June 1965. These systems operate as independent computers and the work flows through them in sequence as required. They share tape drives so that the configuration is somewhat adaptive to the work load via a series of manually operated tape switches. Both the IBM and the RCA equipments are connected in this way.

The dollar figures given in the following statements are for single shift monthly rental and include costs for single shift maintenance where components have been purchased. This is not the full amount paid to the vendor in any one month. The figures given are the rental for 176 hours of usage in a calendar month, if no extra shift is required. However, the total usage measured from the time recording meters is approximately two full shifts. This increases the rental by

approximately $40,000. Thus our actual rent paid to vendors is about $133,000 per month.

2.1.4.1. IBM 7090

This is a binary, 36-bit word-oriented parallel transfer computer designed for scientific data processing. The system has 32K words of 36 bit memory, a memory cycle time for 2.18 microseconds per word, two independent I/O channels, limited card I/O, and 11 magnetic tape drives, one of which is shared with the 1401. It was installed in August 1963, has one purchased component and a net basic cost of $54,990/month

2.1.4.2. IBM 1410

This is a decimal, 6-bit character-oriented machine with some parallel operation for commercial data processing. The system has 80K characters of 6 bits each, a memory cycle of 4.0 microseconds per character, two independent I/O channels, fast card I/O and 10 tape drives, one of which is shared with the 1401. It was installed in January 1963, has no purchased components and a basic cost of $22,380/month

2.1.4.3. IBM 1401

This is a decimal, 6-bit, character-oriented machine with no parallelism. It is used for both primary input and output and for limited commercial data processing. The system had 8K characters of 6 bits each, a memory cycle time of 11.5 microseconds per character, fast card I/O, and two tape drives, both of which may be shared. It was installed in January 1963, has no purchased components and a basic cost of . . . $ 7,265/month

2.1.4.4. RCA 501

This is an octal, 6-bit, character-oriented machine with limited parallelism. It is used for commercial data processing. The system has 32K characters of 6 bits each, a memory cycle time of 12 microseconds per 4 six bit characters, no card I/O, and 8 tape drives, one of which is normally assigned to the RCA 301. It was installed in October 1960, has three purchased components and a net basic cost of. . . . . $ 4,629/month*

* These costs allow for 7 tape drives on 501 system and 1 tape drive on the 301 system.

2.1.4.5. RCA 301

This is a decimal, 6-bit, character-oriented machine with no parallelism. It is used both for primary input and output and for limited commercial data processing. The system has 10K characters of 6 bits each, a memory cycle time of 7 microseconds per character, fast card I/O and one tape drive permanently assigned. It was installed in November 1962, has no purchased components and a basic cost of . . . . . $ 4,586/month

The total net basic monthly cost of the 5 systems is. $93,850/month

2.2. SOFTWARE

OCS has five different computers each of which uses a different programming language. COBOL provides a theoretical compatibility among the RCA 501, IBM 7090 and the IBM 1410. However, until 1964 the RCA 501 COBOL had a very inefficient compiler and in practice was not used because of excessive compile time. Although COBOL compile speeds are good on the IBM 1410 and 7090, actually little exchanging of programs is done because of the hardware incompatibilities:

the 1410 is variable length and decimal while the 7090 is fixed word and binary. In addition, inconsistencies exist in the compilers so that programmers become discouraged from interchanging COBOL programs among machines.

The FORTRAN II used on the IBM 1410 is not completely compatible with the FORTRAN II available for the IBM 7090. In addition, the obsolete FORTRAN II has been replaced by FORTRAN IV on the IBM 7090.

The IBM 1401 programs may be run on the IBM 1410 using the hardware compatibility feature. This use requires interruption of the flow of work using the 1410 Operating System and does not exploit multiple channels and overlap features of the 1410.

2.2.1. 7090 Software

IBM 7090 IBSYS V-12B is the standard operating system in OCS. It includes FORTRAN IV, COBOL, SORT, 9PAC, COMIT, FORTRAN II, FAP, MAP, ASP, SUPPAC, and various math and CALCOMP subroutines. No remote interrupt capability or interrupt features for multiprogramming or time-sharing exist without extensive hardware modification.

The system contains a batch processing monitor which provides some powerful specific features. The IBSYS monitor is the most used monitor system in the world, and its construction reflects its position in the historical evolution

of monitors. It was one of the first large monitors and thus reflects some primitive concepts of design. Also, because of its wide use by the majority of the large-scale scientific computer users in the world, it incorporates powerful features to do scientific computing tasks under the batch mode. IBSYS as a system is rapidly becoming obsolete, and IBM is no longer actively supporting research for major improvements. Incidental improvements will continue through users and through the users' organization, SHARE.

Very little practical possibility exists to adapt the IBM 7090 to a time-sharing, remote console, real-time environment. The software does not exist, and could not be written without extensive modifications to the hardware. The product would, at best, be obsolete and uneconomical by state of the art standards.

2.2.2. 1410 Software

PR-155, the current OCS 1410 system, includes AUTOCODER, SORT/MERGE, FORTRAN II, and COBOL. The batch monitor is well designed but lacks some of the features of IBSYS. The hardware does not provide the interrupts for next era computing and no amount of software modification can bring the total system to the state of the art for 1966-67. Analysis of the internal implementation indicates many com-

promises in order to get the system working. For example, the FORTRAN compiler is basically a simulation of the 7090 instead of being designed for the IBM 1410. At the present time, it is considered a smooth system, but its long range possibilities are nil.

2.2.3. 1401 Software

This is a small non-monitored system designed for I/O support. No future potential exists.

2.2.4. 501 Software

The 501 software package contains an EZCODE assembler, two COBOL Compilers, two Sort/Merge packages, and a Sequencer (monitor). The RCA 501 COBOL compiler is inefficient, and the assembler is considered primitive. RCA has not produced first-class software for its hardware, which is generally considered to be reliable and to have a good, powerful instruction set. It is highly unlikely that RCA will produce acceptable software for the RCA 501 at this late date.

2.2.5. 301 Software

This non-monitored system is designed for I/O support. No future potential exists.

2.2.6. Manuals/Training Materials

Most OCS programmers know at least one machine well and are familiar with at least one other machine. Thus,

each possesses, or must have closely available, at least two sets of manuals. A master notebook containing all manuals for each major machine is kept in appropriate OCS offices and this notebook is maintained by the Technical Staff. Considerable time is spent in keeping these notebooks up to date. The master copy of this set of manuals and notebooks requires approximately 80 linear feet of storage space. A significant amount of this footage deals with low level languages.

Training materials are extensive. The Technical Staff has course outlines, manuals, tests, and sample problems for a variety of languages. The preparation of frequent seminars to deal with hardware/software incompatibilities has used many hours of top technical talent.

2.3. OPERATING STATISTICS

Each computer center keeps operating statistics to control its own internal processes. These are used by the computer center management to review operations for budgetary purposes, to anticipate hardware overloads based on established growth patterns, to provide a measure of the support furnished to various customers and projects, to show the way the computer was used (test, debug, production, maintenance, etc.). Our internal accounting is based on manually-kept

records. At present, time-of-day clocks are not installed on four of the five computer systems; therefore, the operating systems may not interrogate them. The system proposed in Chapter 5 will have integrated accounting and record keeping completely under the control of the operating system. This will relieve the operating personnel of one task which sometimes suffers in the attempt to keep the equipment operating.

2.3.1. Directly Chargeable Hours

The table that follows gives a breakdown of hours by computer that can be directly charged to the four Directorates served. These hours do not include such overhead hours as idle, training, demonstration, software maintenance, and hardware maintenance.

S E C R E T

COMPUTER HOURS CHARGEABLE TO SUPPORT THE DIRECTORATES

(February 1965 through May 1965)

Computer System	DD/I	DD/S	DD/S&T	DD/P	Total
IBM 7090	128	101	1319	98	1646
IBM 1410	471	536	663	62	1732
IBM 1401	394	157	765	63	1397
RCA 501		1723			1723
RCA 301		1301			1301

S E C R E T

2.3.2. 7090 Utilization

For the four-month period February-May 1965 the IBM 7090 computer system was in use for the hours shown. The totals in this table exceed the summary totals given in section 2.3.1. due to certain computer hours which are classed as overhead to computer operations.

HOURS OF 7090 USAGE BY ACTIVITY

February through May 1965

ACTIVITIES	FEBRUARY	MARCH	APRIL	MAY	TOTAL
Production	252	199	278	256	985
Development	126	110	148	174	558
Setup	72	79	92	85	328
Maintenance	32	37	28	38	135
Idle	80	135	50	65	330
Total	562	560	596	618	2336

2.3.3. 1410 Utilization

For the four-month period the IBM 1410 computer system was in use for the hours shown. The totals in this table exceed the summary totals given in section 2.3.1. due to certain computer hours which are classified as overhead to computer operations.

HOURS OF 1410 USAGE BY ACTIVITY

February through May 1965

ACTIVITIES	FEBRUARY	MARCH	APRIL	MAY	TOTAL
Production	220	310	314	278	1122
Development	122	162	145	152	581
Setup	77	77	79	78	311
Maintenance	47	28	63	35	173
Idle	55	49	33	26	163
Total	521	626	634	569	2350

2.3.4. 1401 Utilization

For the four-month period the IBM 1401 computer systems were in use for the hours shown. The totals in this table exceed the summary totals given in section 2.3.1. due to certain computer hours which are classed as overhead to computer operations.

HOURS OF 1401 USAGE BY ACTIVITY

February through May 1965

ACTIVITIES	FEBRUARY	MARCH	APRIL	MAY	TOTAL
Production	174	191	225	197	787
Development	115	177	154	121	567
Setup	69	102	100	91	362
Maintenance	15	5	14	12	46
Idle	188	137	103	152	580
Total	561	612	596	573	2342

2.3.5. 501 Utilization

For the four-month period the RCA 501 Computer system was in use for the hours shown. The totals in this table exceed the summary totals given in section 2.3.1. due to certain computer hours which are classed as overhead to computer operations.

HOURS OF 501 USAGE BY ACTIVITY

February through May 1965

ACTIVITIES	FEBRUARY	MARCH	APRIL	MAY	TOTAL
Production	330	322	340	400	1392
Development	72	110	94	70	346
Setup	56	62	51	61	230
Maintenance	72	84	69	77	302
Idle	41	35	36	46	158
Total	517	613	590	654	2428

2.3.6. 301 Utilization

For the four-month period the RCA 301 computer system was in use for the hours shown. The totals in this table exceed the summary totals given in section 2.3.1. due to certain computer hours which are classed as overhead to computer operations.

HOURS OF 301 USAGE BY ACTIVITY

February through May 1965

ACTIVITIES	FEBRUARY	MARCH	APRIL	MAY	TOTAL
Production	296	308	267	296	1167
Development	128	143	131	165	567
Setup	40	36	29	33	138
Maintenance	18	27	16	21	82
Idle	89	99	147	139	474
Total	571	613	590	654	2428

Chapter 3.

CURRENT PROJECTS

The recurring production jobs are enumerated in this chapter. One-time jobs, internal scheduling and monitoring, training runs, and computer support development efforts (which in the aggregate involve a large amount of computer time) are not itemized. These figures are a further breakdown of the production totals shown in Chapter 2.

3.1. SCIENTIFIC COMPUTING

Following is a summarization of the present scientific computing workload. The workload is subdivided by type, followed by an explanation of the activity, customers, average machine usage per month, etc.

3.1.1. Air Defense System Simulation

This category consists of problems in the areas of general air defense systems, radar ranging analysis and hit and intercept probabilities. The customers for this effort are OSI, OSA, and ORR. In a typical month, these operations account for 4.7 hours of 7090 time and 3.2 hours of 1401 time.

3.1.2. Trajectory and Orbital Analysis

Involves problems related to satellite coverage, orbital determination and analysis, missile characteristics evaluation,

aircraft trajectory simulations, space mission analysis and launch date analysis. Customers for such computations are OSI, SPS, FMSAC, and ORR. This effort normally accounts for 157.9 hours of 7090 time and 111.7 hours of 1401 time each month.

3.1.3. Electronics Intelligence Analysis(ELINT)

Affiliated with problems in radar systems analysis, radar signal analysis and special ELINT equipment support. The customer for this effort is OEL. A typical monthly effort accounts for 2 hours of 7090 time and 1.8 hours of 1401 time.

3.1.4. Signal Analysis

Problems involved with extraction and identification of analog signals by digital processing and noise analysis. The customers for this activity are OEL, OC, and TSD. The effort accounts for 17.7 hours of 7090 time and 12.1 hours of 1401 time during a typical month.

3.1.5. Telementry Analysis

Affiliated with problems in telemetry systems analysis, telemetry data analysis, telemetry data characteristics and filtering, spectrum analysis, correlation and regression analysis and data plotting. The customers are OSI and FMSAC.

Their operations normally account for 24.3 hours of 7090 time and 23.4 hours of 1401 time each month.

3.1.6. Miscellaneous Mathematical Analysis

This category relates to general problems involved with weather data analysis, general purpose plotting and special purpose assembly routines, cloud coverage of targets, optical problems, plasma, geodetic analysis and projections, radio frequency and antenna analysis, general mathematical and numerical analysis routines and special analyses for various DD/S&T activities. The customers for this effort are SPS, ORD, OEL, ORR, FMSAC, OC, and OSA. A typical monthly effort accounts for 168 hours of 7090 time and 90.3 hours of 1401 time.

3.2. INTELLIGENCE DATA PROCESSING

Current computer projects which are termed intelligence data processing are summarized below. Project names, customers served, and machine use hours are given with a brief description of each job.

3.2.1. COMOR Targeting

The COMOR Photo Working Group (through GCS/RG/T) is the customer. In a typical month this operation accounts for

68.2 hours of 1410 time and 38.1 hours of 1401 time. The computer product serves to control, retrieve, sort, format, and print information on world-wide overhead reconnaissance targets.

3.2.2. FMSAC Information Support

The customer is FMSAC: AID, TAD, and [redacted] In a typical month FMSAC support accounts for 22.5 hours of 1410 time and 1.9 hours of 1401 time. The computer operation provides retrieval and display of data on foreign missile and space vehicle launch operations and other related data. 25X1

3.2.3. Automated Target Information System (ATIS)

The customers for ATIS are DD/S&T: SPS, OSA, OSI, and DD/I: CGS, ORR, and DD/P: [redacted] In a typical month it accounts for 61.6 hours of 1410 time and 5 hours of 1401 time. The purpose is to integrate for retrieval and display machine-language files generated by CIA or other intelligence Agencies on collection and other targets. 25X1A

3.2.4. SAM Sites

The customer for this activity is DD/I: ORR/MRA. In a typical month it accounts for 1.9 hours of 1410 time and 0.6 hours of 1401 time. The function is to control, retrieve, and display information on foreign SAM sites and support facilities.

3.2.5. Aircraft Movements

The customers for this activity is FMSAC/AID; OSI/BMSD; ORR/MRS; and OCI/Mil. In a typical month, it accounts for 15.8 hours of 7090 time and 2.5 hours of 1401 time. It provides control and retrieves information on the movements of Soviet transport aircraft and bans on flight activity.

3.2.6. Soviet Bloc Communications Equipment

The Economic Intelligence Committee (Subcommittee on Electronic and Telecommunications, thru ORR/ERA) is the customer. In a typical month this operation accounts for 5.1 hours of 1410 time. The computer controls and retrieves information on Soviet Bloc Communications equipment.

25X1A

[redacted]

3.2.8. NPIC Requirements

The customer is DD/I: CGS. In a typical month this activity accounts for 7.6 hours of 1410 time and 3.2 hours of 1401 time. The purpose is to control and retrieve records on ad hoc readout requirements levied on NPIC.

25X1A

3.2.10. Missile Tracking Data

The customer for this activity is FMSAC/TAD. In a typical month it accounts for 7.1 hours of 1410 time. Missile and space vehicle tracking data is transferred from paper tape to magnetic tape for storage and retrieval.

3.3. MANAGEMENT DATA PROCESSING

On-going jobs which serve the Support Directorate are summarized below. Projects, customers, and machine use hours are given and each job is explained briefly. Preliminary work is underway on the development of a new Management Information System (MIS).

3.3.1. Agency Training Record (ATR)

The customer for this activity is OTR. In a typical month it accounts for 3.3 hours of 501 time and 3.0 hours of 301 time. Records of Agency-sponsored training are maintained.

3.3.2. Badge File

The customer for this activity is OS. In a typical month is accounts for 2.5 hours of 501 time and 1.0 hours of

301 time. Current lists of assigned badges and areas of clearance are provided for the Badge Office and Night Security Office.

3.3.3. Case Processing Analysis (CAPER)

OS/SRD is the customer for CAPER. In a typical month it accounts for 3.1 hours of 1410 time and 2.1 hours of 1401 time. The computer product serves for analysis of elapsed time on pending clearance cases within divisions.

3.3.4. Special Clearance Center Activity Analysis (SPECLE)

The customer for SPECLE is OS/SCC. In a typical month it accounts for 19.7 hours of 1410 time and 4.5 hours of 1401 time. It processes data for analysis of activity on security clearances.

3.3.5. Medical Staff Test Evaluation

The customer served is OMS/AES. In a typical month, it accounts for 13.2 hours fo 501 time and 8.2 hours of 301 time. The machine function is to score, report, and store results of psychological test batteries.

3.3.6. Vouchered Payroll

The customers are OF, OP, and OBPAM. In a typical month it accounts for 3.0 hours of 1401 time, 44.4 hours of 501 time,

and 67.8 hours of 301 time. The operation is to maintain payroll records and produce salary checks, statements of earnings, deductions, leave balances, and W-2's; provide payroll accounting back-up and audit details, furnish information on excessive use of sick leave, compile data on overtime payments, and produce LWOP accumulations.

3.3.7. Confidential Funds Payroll [redacted] 25X1A and Agents

The customers are OF, OBPAM and OP. In a typical month, it accounts for 27.0 hours of 501 time, 51.0 hours of 301 time, and 2.0 hours of 1410 time. The function is to maintain payroll records and prepare salary checks, statements of earnings and deductions and W-2's; provide accounting back-up and audit trails, compile data on overtime payments, supply the Credit Union with listings of repayment and share items, furnish detailed personnel charges, produce individual deductions for insurance premiums.

3.3.8. Individual Earnings Records

The customer is OF. In a typical month it accounts for 10.0 hours of 501 time and 1.0 hours of 301 time. Pay period records of all personnel and payroll actions on pay, earnings, and deductions are provided.

3.3.9. Cable Traffic Analysis (CATRAN)

The customer of CATRAN is OC. In a typical month it accounts for 3.2 hours of 1410 time and 0.1 hours of 1401 time. It provides statistics on cable traffic for planning personnel requirements, equipment, circuit requirements, etc.

3.3.10. Network Data Lists (COMDAT)

The customer for this product is OC. In a typical month it accounts for 0.1 hours of 1401 time. The computer provides listings of foreign transmitting stations for network analysis.

3.3.11. Safe Combinations (SCRAMBLE)

The customer for SCRAMBLE is OS. In a typical month it accounts for 0.1 hours of 1410 time. Random, unique, three-number safe combinations are developed on the computer.

3.3.12. Logistics Stock Accounting

The customer for this activity is OL. In a typical month it accounts for 80.0 hours of 501 time and 66.0 hours of 301 time. Maintenance of a Master Property File (i.e., stock level and account of property) is provided.

3.3.13. Manufacturers Cross Reference

OL is the customer for this activity. In a typical month it accounts for 6.0 hours of 501 time and 2.0 hours of 301 time. It supports the Defense Logistics Supply Center federal cataloging function.

3.3.14. Forms Control

The customer for this activity is DD/S (Agency-wide distribution). In a typical month it accounts for 2.0 hours of 501 time and 2.0 hours of 301 time. It provides complete documentation of Agency forms.

3.3.15. Personnel System

The customers supported by this system are OP, OBPAM and Credit Union.

3.3.15.1. Agency Language Proficiency Program

In a typical month this operation accounts for 3.7 hours of 501 time and 1.6 hours of 301 time. It provides language proficiency data for Agency staff employees.

3.3.15.2. Agency Personnel Qualifications Systems

In a typical month this system accounts for 7.1 hours of 501 time and 2.5 hours of 301 time. It is an information system pertaining to skills, experience, training, and education of Agency personnel.

3.3.15.3. Agency Strength Accounting

In a typical month this activity accounts for 2.0 hours of 501 time and 0.8 hours of 301 time. It provides official Agency strength reports.

3.3.15.4. Employee Locator

In a typical month this activity accounts for 2.3 hours of 501 time and 3.1 hours of 301 time. This is a locator system for information on personnel; also used to prepare Agency telephone directories.

3.3.15.5. Fitness Reports Processing

In a typical month this activity accounts for 1.5 hours of 501 time and 0.5 hours of 301 time. The operation supports the Agency's Fitness Report Program.

3.3.15.6. Hospitalization Master

In a typical month this activity accounts for 2.2 hours of 501 time and 0.4 hours of 301 time. Current records or personnel enrolled in health benefit plans are maintained.

3.3.15.7. Project MANS

In a typical month this project accounts for 1.7 hours of 501 time and 1.0 hours of 301 time. It is an automated system to align T/O positions with budget programs, activities, categories, etc.

3.3.15.8. Periodic Step Increases

In a typical month, 2.4 hours of 501 time and 1.4 hours of 301 time are accounted for. It is a computerized call-up and control mechanism in support of periodic step increases.

3.3.15.9. Personnel Archives Project

In a typical month this project accounts for 2.1 hours of 501 time. It furnishes historical back-up for the Statistical Reporting Branch (SRB).

3.3.15.10. Insurance File

In a typical month this activity accounts for 0.4 hours of 501 time. Listings of various insurance policy accountings are furnished to the Insurance Branch.

3.3.15.11. Record of Overseas Service

In a typical month this activity accounts for 0.9 hours of 501 time and 0.3 hours of 301 time. It is a central file of data on personnel who have served overseas.

3.3.15.12. Statistical and Related Reports

In a typical month this system accounts for 10.0 hours of 501 time and 4.1 hours of 301 time. It is a record keeping reporting system.

3.3.15.13. Temporary Definite Status (NTE)

In a typical month NTE accounts for 0.9 hours of 501 time and 0.4 hours of 301 time. Records of all Agency employees designated as NTE--"Not to Exceed" are maintained.

3.3.15.14. T/O Related Processes

In a typical month this activity accounts for 11.8 hours of 501 time and 15.6 hours of 301 time. Its function is to maintain records reflecting job-to-incumbent relationship.

3.3.15.15. Credit Union Rosters

In a typical month this program accounts for 3.5 hours of 410 time. It produces data for maintaining individual ledger records, a reference aid, and source of information.

3.3.15.16. CIA Retirement System

In a typical month, this system accounts for 2.0 hours of 1410 time and 1.0 hours of 1401 time. Rosters are prepared to aid the Career Services in the selection of personnel eligible for retirement.

3.3.15.17. Agency Early Retirement System

In a typical month this system accounts for 0.2 hours of 501 time and 0.1 hours of 301 time. It supports the Agency's Early Retirement Program.

3.3.16. Accounting System

The customers for this system are OBPAM and OF. In a typical month it accounts for 109.0 hours of 501 time and 66.0 hours of 301 time.

3.16.1. Budgetary Accounting

Data in various financial files are processed for OBPAM to determine project costs, budget projections, and program analysis.

3.3.16.2. Daily Accounting

Original accounting entries are listed to support source documents and furnish statements of advance accounts, and cash accounts.

3.3.16.3. Financial Analysis Number (FAN)

The purpose is to maintain a file of valid FAN accounts, print the FAN Directory, support program analysis and budget preparation, and eliminate manual posting of records in Agency offices.

3.3.16.4. General/Subsidiary Ledger Accounting

To process transactions for the general/subsidiary ledgers, to prepare various listings for analysis by the Office of Finance, and to maintain accounts.

3.3.16.5. Obligation, Expenditures, Issue, and Cost Reporting

The computer is used to prepare listings and reports for analysis of control of expenditure, issue, and cost data.

3.3.16.6. Reciprocal and Reconciliation Accounting

The function is to maintain accounts and furnish detailed information for the reciprocal and reconciliation accounts.

3.4 COMMO OPERATIONS SUPPORT

OCS is supporting the Office of Communications with several on-going computer projects which are listed below.

3.4.1. Machine Analysis

In a typical month this job accounts for 0.7 hours of 1410 time. This is a specialized machine analysis.

3.4.2. Code Evaluation

In a typical month these machine runs account for 1.2 hours of 1410 time. This is a specialized evaluation.

3.4.3. Agent Transmission Schedules

In a typical month this activity accounts for 0.1 hours of 1410 time. It serves to generate, test, and format random times for agent transmissions.

3.4.4. Communications Statistical Analysis

In a typical month this accounts for 0.8 hours of 1410 time. Special statistical analysis services are provided.

3.4.5. Code Tables

In a typical month this activity accounts for 3.8 hours of 1410 time. The computer is used to generate, test, and

print random groups of numbers and/or letters used in constructing signal plans, call sign tables, and code groups.

25X1

[redacted]

3.4.8. Position Status Index

In a typical month this accounts for 0.5 hours of 1410 time. It controls information on communications plans position by position.

3.5. STATISTICAL DATA PROCESSING

The on-going statistical jobs are listed and explained below.

3.5.1. Soviet Military Expenditures

The customer for this project is ORR/MRA. In a typical month, it accounts for 22.3 hours of 7090 time and 15.1 hours of 1401 time. The function is to compute, summarize, and print figures on Soviet military expenditures at several levels of detail.

25X1

[redacted]

25X1

25X1

3.5.3. Battery Test

The customer for this project is TSD/ In a typical 25X1 month it accounts for 0.8 hours of 7090 time and 2.5 hours of 1401 time. The computers perform statistical analysis of data resulting from tests of battery power sources.

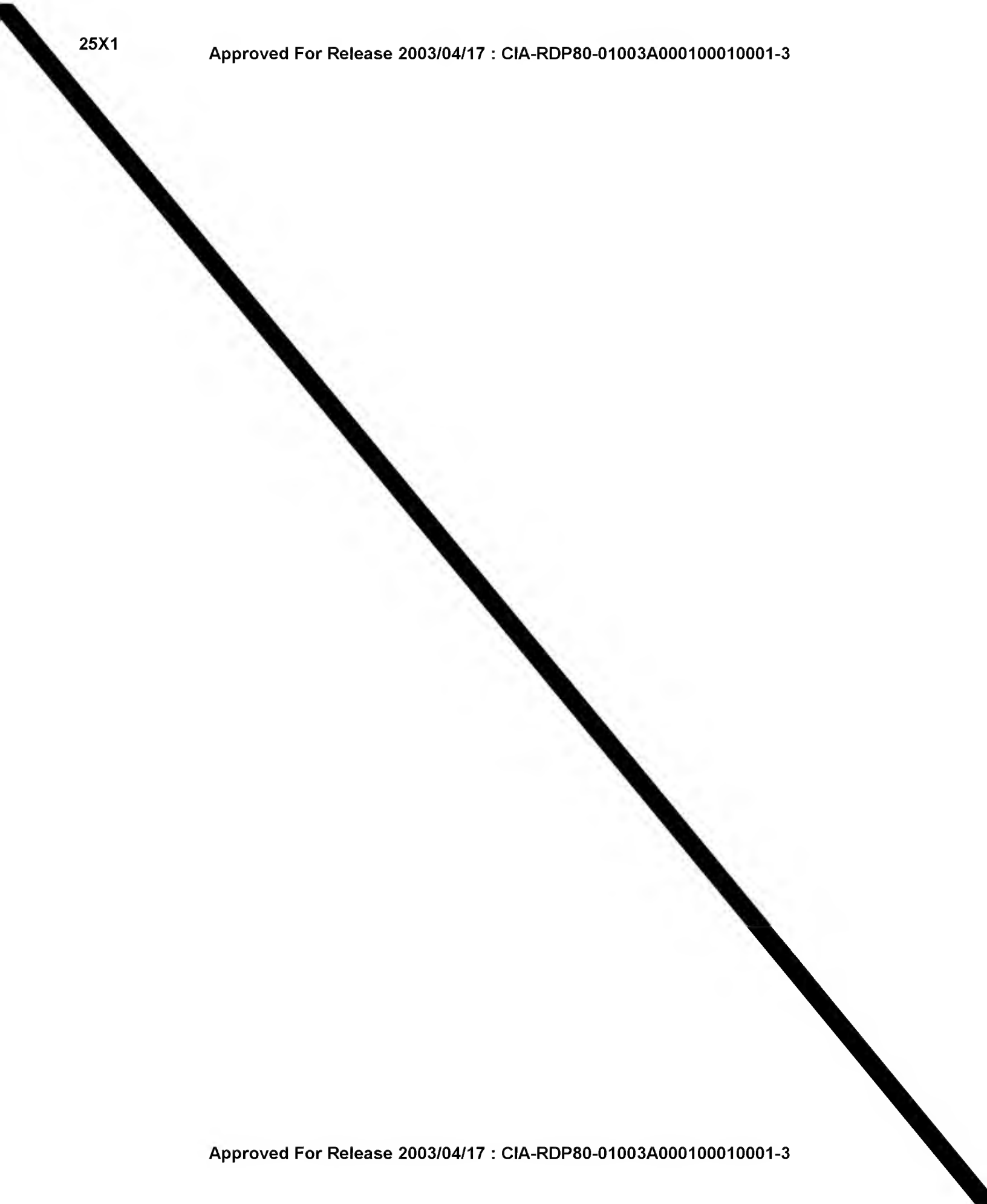
3.5.4. Soviet Production Indexes

The customer for this project is ORR/ERA. In a typical month it accounts for 0.8 hours of 1410 time. The Soviet GNP in the civilian sector of the economy is computed.

3.5.5. Grants and Credits

The customer for this project is the Economic Intelligence Committee (thru ORR/ERA). In a typical month it accounts for 7.9 hours of 1410 time and 0.1 hours of 1401 time. Computers are used to control and print summary and detailed information on Soviet Bloc and Chinese grants and credits to underdeveloped countries.

25X1B



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Chapter 4

PROJECTED WORKLOAD

This chapter deals with monthly increases over the present computer workload which, though excessive to on-hand hardware capabilities, can be accommodated by the planned system. Required computer time is shown in terms of present hardware where feasible. However, projected requirements which cannot be handled on present type hardware are estimated for third generation hardware of the required capability.

4.1. SCIENTIFIC COMPUTING

A large part of the projected growth in the computer workload as of the end of 1968 is attributable to increased activity on scientific computing jobs which are already operational. The total increase in scientific computing time is estimated to be over 646 hours on the 7090.

4.1.1. Air Defense System Simulation

The customers for this activity are OSI and the Office of the DD/S&T. The projected growth in workload on this activity will require an additional 32 hours of 7090 time and 26 hours of 1401 time. The computing work relates to radar simulation, flight path simulation and SAM performance against target problems.

4.1.2. Trajectory and Orbital Analysis

The customers for this effort are ORR, SPS, and FMSAC. The projected growth in workload on this activity will necessitate an additional 242 hours of 7090 time and 177 hours of 1401 time. The computing effort relates to simulation of powered and free flight trajectories, orbital analysis, satellite field-of-view coverage, and vehicle characteristics determination.

4.1.3. Electronics Intelligence Analysis (ELINT)

The customer for this computer support is OEL. Projected growth in workload for this activity will necessitate an additional 14 hours of 7090 time and 13 hours of 1401 time. The computing work relates to radar signal analysis.

4.1.4. Signal Analysis

The customers for this activity are DD/S&T and DD/S. The projected growth in the workload on this effort will require an additional 29 hours of 7090 time, 160 hours 360/30 time and 16 hours of 1401 time. The computing effort relates to signal analysis of analog data, noise analysis, etc.

A flexible Analog Digital Laboratory Device including extensive systems and analysis software is in process of

being designed and assembled. The device will permit high speed analog-to-digital conversion by providing the capability of handling taped data at very high throughput rates (45.6 megabits/second maximum).

The device will be interfaced with the in-house System 360 computer for fast data reduction, production, and analysis. Also, the analog-to-digital device will be under System 360 computer control. A display and control console will be provided for manual override of the entire conversion system. Once experience has been acquired for the handling of both the equipment and data, coupled with the concurrent development of sophisticated and efficient analysis techniques and software, it is envisioned that such a device will enable the conversion of an enormous amount of data. Such data are currently either not being processed due to excessive volume or are being processed manually with extensive data loss. Data sources for this equipment are: ELINT, acoustical data, biomedical data, telemetry, etc.

4.1.5. Telemetry Analysis

The customers for this activity are FMSAC and OSI. The growth of this activity is projected to be an additional 24 hours of 7090 time and 23 hours of 1401 time.

4.1.6. Miscellaneous Mathematical Analysis

The customer for this activity is DD/S&T. The projected growth in the workload will necessitate an additional 80 hours of 7090 time and 42 hours of 1401 time. The computing

workload relates to solving miscellaneous mathematical and numerical analysis problems, problems in optics, general and special purpose plotting routines and geodetic projection analysis.

4.2. INTELLIGENCE DATA PROCESSING

By the end of 1968 about 70 additional hours of 1410 computer time, 10 hours of 1401 time, and 8 hours of 7090 time will be required to handle the planned increase in the intelligence data processing workload. This estimate is based on the capabilities of present OCS hardware.

4.2.1. COMOR Targeting

The customer for the targeting project is the COMOR Photo Working Group. The projected growth in the computer workload will require an additional 7.0 hours of 1410 time and 2.0 hours of 1401 time. The computing work relates to improving input procedures and system products. (Major improvements are dependent on DASD and remote devices.)

4.2.2. FMSAC Information Support

The customers supported by this activity are FMSAC: AID, TAD, and [redacted] The projected growth in the workload on this activity will require an additional 50.0 hours of 1410

25X1

time and 4.0 hours of 7090 time. The computing work relates to improving input/output procedures for faster response times, developing a new sub-system for the Control Center, and studying event prediction models. (Major improvements are dependent on DASD and remote devices.)

4.2.3. Automated Target Information Files (ATIS)

The customers for the Automated Target Information Files are SPS, OSA, OSI, CGS, ORR [redacted] The projected growth 25X1A in the workload on this activity will require an additional 9.0 hours of 1410 time, 4.0 hours of 1401 time, and 8.0 hours of 7090 time. The computing work relates to integrating additional files into the system, improving output capability with emphasis on graphics and map plots, and decreasing response time. (Some improvements are dependent on DASD and remote devices.)

4.3. MANAGEMENT DATA PROCESSING

By the end of 1968 the projected increase in computer use time required to handle the planned growth in management support jobs totals 24 hours of 501 time, 25 hours of 301, 275 hours of 1410, and 1.1 hours of 360/65 per month.

4.3.1. Badge Office Files Consolidation Study

The customer for the Badge Office Files Consolidation

Study activity is the Building Security Branch, OS. The projected growth in the workload on this activity will require an additional 18.0 hours of 1410 time. The computing work relates to consolidating six small files presently held by the Badge Office.

4.3.2. Biographic Profiles

The customer for the Biographic Profiles activity is the Office of Personnel. The projected growth in the workload on this activity will require an additional 14.0 hours of 501 time. The computing work relates to preparing clear text profiles from data taken from the Agency Central Qualification File and other related personnel files.

4.3.3. Junior Officer Trainee Program

The customer for the Junior Officer Trainee Program is the Office of Personnel. The projected growth in the workload on the activity will require an additional 4.0 hours of 501 time and 2.0 hours of 301 time. The computing work relates to establishing and maintaining a magnetic tape record reflecting all action taken with respect to personnel in the program--past or present.

4.3.4. Contract Accounting and Reporting System (CONARS)

The customer for the Contract Accounting and Reporting System is DD/S&T, Plans and Program Staff. The projected growth in the workload on this activity will require an additional 6.0 hours of 1410 time. The computing work relates to developing a system to do file maintenance and produce periodic reports on Agency contracts based upon contract type, contract subject matter, and contract financial accounting.

4.3.5. Security Automated Name Check Activity (SANCA)

The customer for the Security Automated Name Check Activity is OS, Security Records Division. The projected growth in the workload on this activity will require an additional 170.0 hours of 1410 time. The computing work relates to providing a computer-oriented tape look-up index system for name traces and leads to the SRD files.

4.3.6. Study of Cable Secretariat Procedures for Possible Automation

The customer for this study is the Cable Secretariat. The projected growth in the workload on this activity will require an additional 1.1 hours of 360/65 time. The computing work relates a study of the present procedures in the

Cable Secretariat with a view toward possible automation of some of the steps in the system.

4.3.7. Computer-Assisted Book Composition (EPIC) (Electronic Printing of Intelligence Composition)

The customer for EPIC is Office of Logistics, Printing Services Division. The projected growth in the workload on this activity will require an additional 40.0 hours of 1410 time. The computing work relates to the development of a computer system that will produce book composition text in formatted, justified form for input in machine language to electronic computing and composing equipment.

4.3.8. Credit Union Study

The projected growth in the Credit Union workload will require an additional 11.0 hours of 1410 time. The computing work relates to the investigation of the appropriateness of a computer system to maintain share and loan balances and compute interest.

4.3.9. Agency Personnel Qualifications System

The customer for the Agency Personnel Qualifications System is the Office of Personnel. The projected growth in the workload on this activity will require an additional 20.0 hours of 301 time. The computing work relates to the complete operational function of querying and searching master file.

4.3.10. Hospitalization Master

The customer for the Hospitalization Master activity is the Office of Personnel. The projected growth in the workload on this activity will require an additional 3.0 hours of 501 time. The computing work relates to revision to allow one data entry and reduce and clarify clerical procedures.

4.3.11. Project MANS

The customers for Project MANS are the Office of Personnel and OBPAM. The projected growth in the workload on this activity will require an additional 2.0 hours of 501 time and 1.0 hours of 301 time. The computing work relates to revision of reporting formats, including additional data and additional reports.

4.3.12. Insurance File

The customer for the Insurance File activity is the Office of Personnel. The projected growth in the workload on this activity will require an additional 2.0 hours of 501 time and 1.0 hours of 301 time. The computing work relates to the reduction of punched card and clerical operations and optimizing computer runs.

4.3.13. Record of Overseas Service

The customer for the Record of Overseas Service activity

is the Office of Personnel. The projected growth in the workload on this activity will require an additional 0.1 hours of 501 time. The computing work relates to the elimination of error from files and providing computer editing.

4.3.14. Logistics Stock Accounting

The customers for the Logistics Stock Accounting activity are OL, OC, OS, OF, TDS, [redacted] The projected growth in the workload on this activity will require an additional 20.0 hours of 1410 time. The computing work relates to the designing of a new system to meet requirements of OL. (This may be combined with MIS).

25X1A

4.3.15. Manufacturers Cross Reference

The customer for the Manufacturers Cross Reference activity is the Office of Logistics. The projected growth in the workload on this activity will require an additional 10.0 hours of 1410 time. The computing work relates to converting the present system to IBM equipment.

4.3.16. CIA Retirement System

The customers for the CIA Retirement System are Office of Personnel and Office of Finance. The projected growth in the workload on this activity will require an additional 10.0 hours of 501 time. The computing work relates to provision for inclusion into existing personnel and pay systems and

establishing an accounting and paying mechanism for annuitants, survivors, and participants.

4.3.17. Agency Training Record (ATR)

The customer for the Agency Training Record activity is the Office of Training (Registrar). The projected growth in the workload on this activity will require no additional computer time. The computing work relates to provision for inclusion into Qualifications System by computer methods.

4.3.18. Financial Analysis Number (FAN)

The customers for the Financial Analysis Number activity are the Office of Finance and OBPAM. The projected growth in the workload on this activity will require an additional 4.0 hours of 501 time and 2.0 hours of 301 time. The computing work relates to providing additional reports for Confidential Funds by inclusion of detail obligations.

4.3.19. Vouchered Payroll

The customers for the Vouchered Payroll activity are the Office of Finance, Office of Medical Services, OBPAM, and Office of Personnel. The projected growth in the workload on this activity will require an additional 0.2 hours of 501 time. The computing work relates to the provision for

inclusion of all payroll accounting entries through the existing computer system.

4.4. COMMUNICATIONS OPERATIONS SUPPORT

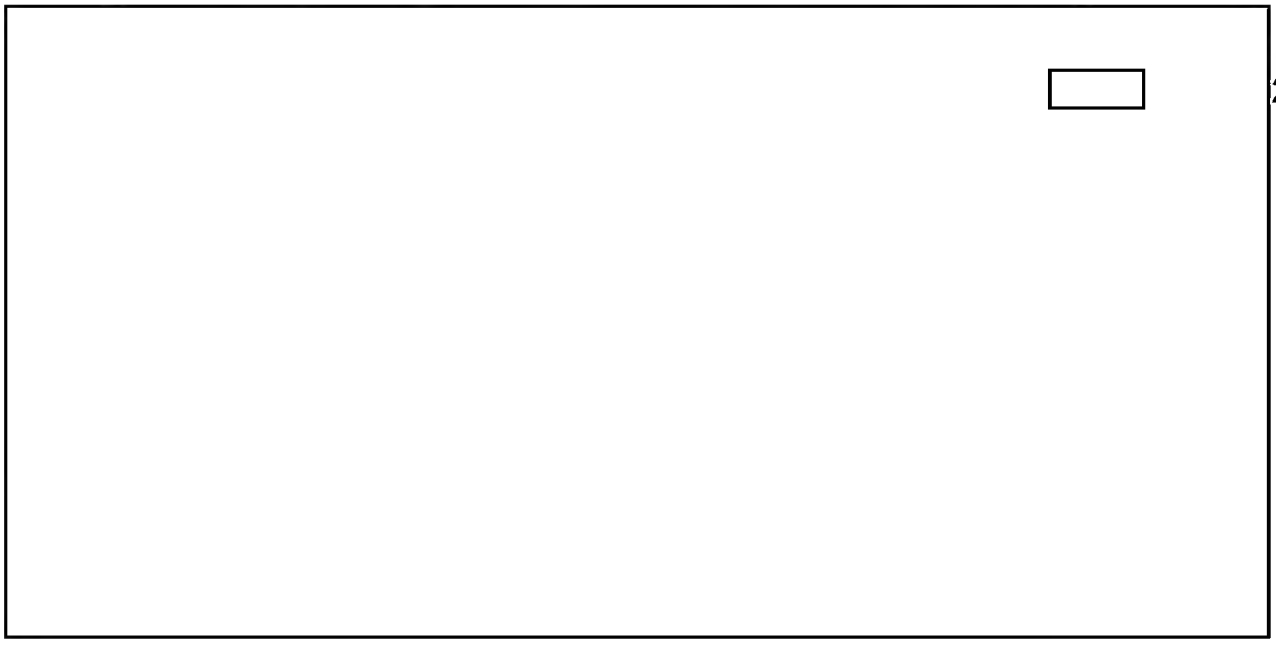
No increase in the present workload or new COMMO support jobs have been identified. However, this is an area in which computer support to date has been quite beneficial. Therefore, growth, though not predictable in volume, is to be expected.

4.5. STATISTICAL DATA PROCESSING

The projected increase in required computer time for statistical jobs amounts to 25 hours of 7090 time and 21 hours of 1401 time per month. The three projects which account for this increase are included below.

4.5.1. Soviet Military Expenditures

The customer for the Soviet Military Expenditures activity is ORR/MRS. The projected growth in the workload on this activity will require an additional 8 hours of 7090 time and 10 hours of 1401 time. The computing work relates to increasing the power of the system by building cost models, developing graphic outputs, improving input procedures for file maintenance, applying game theory where possible, and supporting DIA costing requirements. (Some improvements are dependent on DASD and remote devices).



25X1

25X1

4.5.3. Battery Test

The customer for the Battery Test activity is TSD/ 25X1 The projected growth in the workload will require an additional 15 hours of 7090 time and 6 hours of 1401 time. The computing work relates to a greatly increased amount of data to be processed as a result of an enlarged test program for battery power sources and from the development of battery life simulation.

4.6. DOCUMENT/INFORMATION RETRIEVAL

Project CHIVE is the large scale document/information retrieval system under development in the Agency. To date computers have been used to support experimental work on

this project. The amount of such computer time has varied considerably from month to month. One segment of the total computer-driven CHIVE system will be implemented initially. It is estimated that 15 hours of 360 mod 67 computer time be required monthly by 1967.

4.7. LANGUAGE PROCESSING

The automatic Language Processing (ALP) System, currently under development by IBM, is scheduled to be installed in the Agency by October 1965. The initial system will consist of special purpose hardware interconnected to a 1401 computer. Its two modes of operation will a) perform stenotype machine shorthand transcription to English and b) perform machine assisted translation from Russian to English. If proven successful, the special purpose ALP hardware will be interconnected with the planned major computer system. The estimated 360 Mod 67 time required per month is 8 hours.

Chapter 5.

PROPOSED SYSTEM

5.1. SYSTEM 360 HARDWARE

In April, 1964, the IBM Corporation announced a family of computers known as System 360. At the time of announcement five different models were announced. Each of these five models was to have exactly the same logical structure, instruction set, and options. The five machines differed in speed and price. The Model 30, the low end of the scale, was the slowest and least expensive. The model 70, the high end of the scale, was the largest and most expensive. These machines bracketed the performance range from the 1401 size machine to a machine somewhat larger than the 7094-II. In addition to their common design, the machines were fundamentally unique for two reasons. First, they were a compromise design which would accomplish both business data processing and scientific computing on one computer with an acceptable throughput per dollar. Second, they had a unique instruction format which was economical in terms of core storage, and which allowed large core memories to be directly connected and addressed in a straightforward manner.

Since the original announcement, two more machines have been added to the series. The Model 20 is a small computer

with price and performance below the Model 30. It is a cousin to the Model 30 in that programs prepared for the Model 20 will run on the Model 30, but not conversely. At the extreme high end of the line, the Model 92 was announced. The Model 92 is bigger and faster than either the Stretch, the Larc, or CDC's 6600. It is completely compatible with the remainder of the line with the exception that the commercial option is not available for the Model 92 since it is primarily intended for heavy scientific computation.

In the 15 months since announcement, improvements have continued to flow from the design laboratory. One machine has had its memory cycle time reduced and is being offered with the faster memory at the original price, thus increasing its throughput per dollar. The Models 60 and 62 have been discontinued, and are replaced by the Model 65, faster machine at a lower price. New input/output gear has been announced and additional devices are rumored. A special configuration, the Model 67 has been announced to satisfy the market demand for a machine to support remote consoles, time-sharing, and a commercial machine which will allow dynamic reconfiguration for those installations which require high availability at a reasonable price.

5.1.1. Introduction to System/360

System/360 is a stored program, general purpose digital

computer with unique capabilities. The same design is implemented in a series of CPU's to offer a range in speed and performance. The various models are each constructed from a family of new circuits called SLT (Solid Logic Technology). These SLT circuits are the result of several years circuit development which has resulted in a series of integrated digital circuits which can switch their logic states in ten to thirty nanoseconds (billionths of a second). To exploit the productive capacity of this new family of circuits, IBM has implemented the S/360 CPUs so that the smaller machines use the same family of circuits but merely work them harder. This is most clearly seen in the width of the bus to memory. The bus on the Model 30 is only 8 bits wide. Thus, it has an 8 bit adder and performs arithmetic 8 bits at a time. As the models increase in speed, the width of the memory bus grows 8, 16, 32, and 64 bits wide.

As indicated above, the design of S/360 was chosen to allow the attachment of large capacity memories. In previous designs the number of address bits in a computer instruction had to be sufficient to allow the largest core memory contemplated to be addressed. In S/360, register addressing is used so that the instruction length may be held to a minimum. The actual memory address to be referenced is held in one of six-

teen general registers. When the instruction is fetched, a four bit field in the instruction points to the register which holds the address of the memory cell to be referenced. The registers are 32 bits in length, the address portion is 24 bits long. Using this scheme, a net saving of 20 bits per instruction is possible on the larger configurations. The 16 general registers are also used for arithmetic registers and subroutine linkages.

Some instructions also carry a 12 bit modifier field which allows an offset to be added to the register address immediately preceding the memory reference. These 12 bit fields allow an amount of conventional direct addressing limited to the first 4096 bytes of memory.

The memory itself is organized around the eight bit byte. Each eight bit field has a unique memory address and can be selected, along with one or more contiguous bytes, at the time of an instruction execution. Although each byte is uniquely addressable, a performance penalty is extracted in the event a programmer elects to fetch bytes or strings of bytes which do not start at a natural memory division (8, 16, 32, or 64 bit word boundaries).

The instruction sequencing and interrupt provisions within S/360 embody a large portion of the best design features

historically found to be useful for communications and real-time installations. A mask register is provided which allows the various interrupt conditions to be selectively enabled. When an interrupt has been enabled and the interrupt event occurs, the instantaneous status of all critical registers is stored and the execution of a new stream of instructions is initiated. The conditions stored at the time of interrupt allow the previous instruction stream to be resumed after the immediate processing associated with the interrupt is completed. The various CPU registers are stored into a single formatted word called the Program Status Word (PSW). The special history word so assembled allows the minimum interrupt time to be reduced so that the large interrupt time penalties, associated with some previous machine designs, are not experienced.

The instruction repertoire has the normal complement of instructions to facilitate fixed-point arithmetic, address modification, testing, and sequencing. A commercial instruction set is provided as an option which allows the CPU to perform variable field length decimal arithmetic, and to expeditiously accomplish certain packing and editing functions found in commercial data processing work. A second option, the scientific option, provides additional registers and circuitry to perform floating point arithmetic on either 32

or 64 bit operands.

The fundamental architectural design of S/360 encourages multiprogrammed operation. Three features are responsible for this flavor. First, the CPU embodies the concept that a monitor program is mandatory. As such, there are certain functions reserved to the monitor and only to the monitor. These functions are program switching, accounting, interrupt handling, and all I/O. The instructions to accomplish these functions are called privileged instructions and they cannot be executed by an applications program. A control circuit is set to determine whether the machine is operating in the problem state or the monitor state. Any attempt to execute monitor functions in the problem state is interpreted as an error which initiates an interrupt and calls for monitor action.

To protect the monitor and to protect applications programs which may cohabit in the same core memory, storage protection feature is provided. The monitor assigns each applications program a storage protection key. Whenever a memory reference (either fetch or store) is made, the key associated with the program initiating the action is automatically compared with the lock mechanism associated with that block of core memory. If they match, the memory reference is allowed with no performance penalty. If they disagree, the instruction

execution is terminated and monitor intervention is requested. Thus, two or more applications programs can be protected from each other so that their information is held invoilate. Similarly, the monitor can protect itself from both of these applications programs.

The third feature which facilitates efficient operation in general and multiprogramming in particular is the multiplexing channel feature. Two types of channels are offered on S/360: the selector and the multiplexor. The adjective "selector" is used to specify the traditional type of I/O channel which, when once initiated, can sustain only one I/O operation at a time. In short, it is dedicated to a specific device from initiation to completion. These we have long known and can be considered traditional. On the other hand, the multiplexor channel contains additional registers and control circuitry to allow the data path to be time-shared by several relatively low speed I/O devices on a demand-priority basis.

In any input/output operation, registers must hold the address of the next memory cell to be referenced, the total number of bytes to be transferred, and certain control information associated with the I/O operation itself. A multiplexor channel has a set of these registers for every attached device. A typical channel may have up to 128 sets. When an

operation is started, the registers are initialized and the first memory reference is made. From then on, whenever the device demands (or allows) service, the appropriate set of registers is fetched from a local memory and used to route the next byte to or from main memory. Such a channel is extremely well suited for handling concurrent operations on several slow speed character-oriented devices such as teletypes or remote terminals.

The multisystem features allow two or more CPUs to be connected in a multiprocessing configuration. These provide for CPU to CPU communication, memory priority and tie breaking, a master-slave relationship, and limited types of automatic reconfiguration and recovery in the face of hardware or software malfunctions.

5.1.2. I/O Device Survey

The very flexible channel arrangement on S/360 allows a variety of devices to be connected via multiplexor or selector channels to a CPU whose speed and storage characteristics support their operation. The interface between the channel (either multiplexor or selector) and the control unit is well defined. If manufacturers of special purpose equipment merely meet this channel interface spec, they can directly connect to a 360 channel with no additional hardware or special purpose

circuitry. Thus, it is highly probable that other manufacturers will provide device gear to complement IBM's offerings. However, while this is highly probable, the breadth of IBM's offerings is impressive. A sampler of such devices is provided below.

The IBM 2361 core storage unit can either be used as an extension of memory, or as an I/O device. One or more of these devices may be attached which provide independent access to a 64-bit word double every eight microseconds. Each bulk storage unit will contain 1,048,576 bytes of storage, each nine bits (eight data bits plus one parity bit) wide.

In the domain of rotating storage devices, IBM provides the 2302 disk storage, the 2311 disk storage, the 2321 data cell drive, the 7320 drum storage, and the 2301 drum storage. In addition, they have recently announced the 2314 multidisk. These devices are graded in total capacity, access time, rotational rate.

In the more traditional department of tape drives, they offer five, ranging from the 15 kilobyte 2415 unit to the 340 kilobyte 7340 hypertape unit. While the drives are normally the nine track tape, a seven track compatibility option is also available.

In I/O gear, they offer two card readers: 1402 and the

1442; a punched paper tape reader; an optical mark reader; two magnetic character readers; two optical readers; and four line printers including the 1403-3 which prints at 1100 lines per minute and also provides the interchangeable train cartridge feature. They provide the 2702 control unit which is the interface to the common carrier, and data collection consoles, data communication consoles, terminals, process control attachments, and two versions of CRT displays. To round out the assortment, the graphical display gear, developed in conjunction with General Motors, provides the capability to produce engineering drawings on-line and photograph them for later reuse.

5.1.3. Model 65 Plans

OCS plans to install an IBM model 65 mono-processor in the first quarter of 1966. This machine will have 524,288 bytes of storage with a cycle time of 750 nanoseconds per eight byte word. The configuration planned is shown in figure 1. The single shift monthly rental is $70,000.

The configuration shown is more readily appreciated if it is analyzed by the subsystems and projects it supports. A central CPU-memory-storage complex is provided to support all projects. It consists of the Model 65 processor and its two interleaved core memories, the operator's console, limited on-

IBM SYSTEM /360
MODEL 65 - MONOPROCESSOR

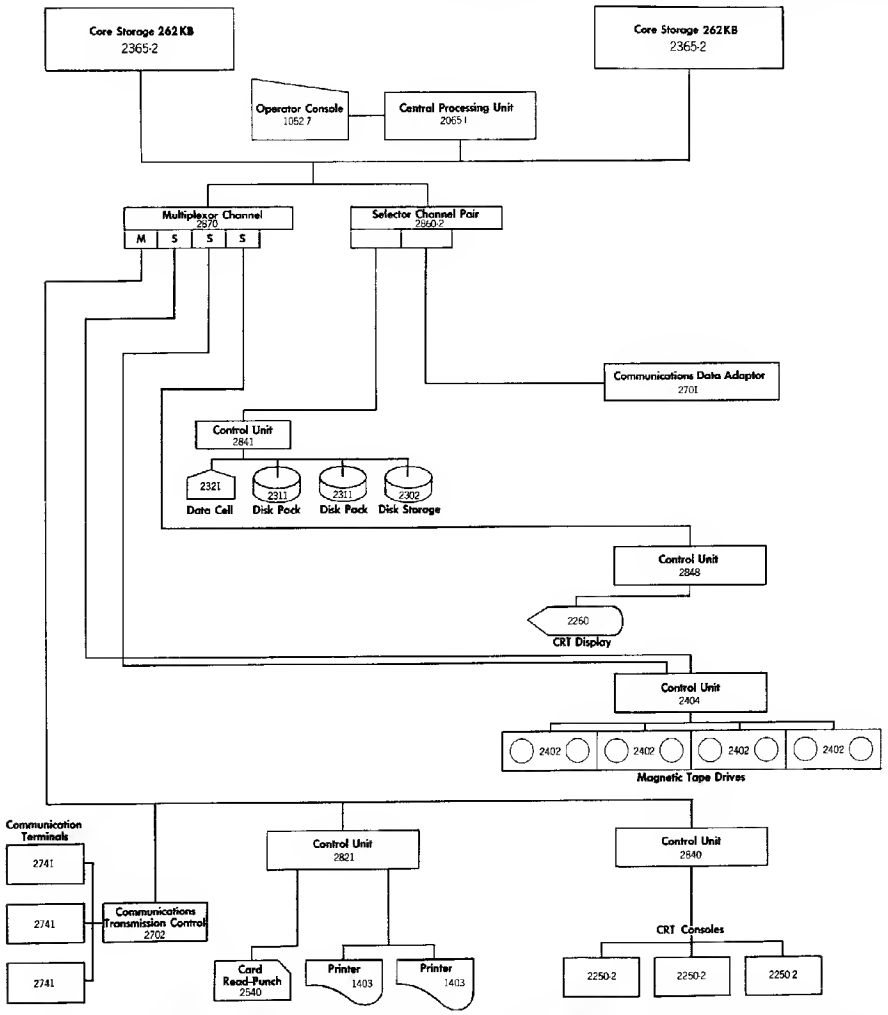


FIGURE 1

line card reading and printing capability, 8 magnetic tape units, and a 2311 disk file for programming systems residence. This is supplemented by a second 2311 for applications program residence and a 2302 disk file for on-line storage with intermediate access and capacity.

Just this much equipment is a very powerful monoprocessor capable of multiprogramming. Jobs and their data may be introduced to this system via an off-line card-to-tape machine, or via the on-line card reading equipment. Output may be taken on-line or written on tape for delayed printing.

To this central processing system, three 2741 terminals have been added to allow the central system to be queried via communication lines from remote terminals not necessarily located in the Headquarters Building. Further, three 2250 CRT terminals have been added to allow the computer's files to be queried and manipulated from the high speed CRT terminal displays located within the Headquarters Building. In order to provide the additional storage necessary for holding files for inquiry and display, the 2321 data cell storage device has been added. This one data cell has the capacity of 400 million bytes.

The third set of devices added to the configuration will allow the direct attachment of the Univac 1004 data communications net and provide an entry point for our special

purpose high-speed analog to digital conversion gear.

This Model 65 is an interim system which will allow us to convert and process the programs now running on four of our five computers, will allow us to start building the large file on the data cell, and will provide an experimental facility so that we may become experienced with the idio-syncrasies of two types of remote terminal devices.

To prepare for this interim system, an IBM Model 30 will be installed in August 1965 to replace the IBM 1401 now performing yeoman service: printing tapes and reading cards. A multi-task utility program is being prepared which will cause the Model 30 to process tasks concurrently as required by operator action. In addition to this yeoman service, the early installation of the Model 30 will allow us to perform these other functions. Since the Model 30 will have both 7 track tapes and 9 track tapes, the file conversion and translation outlined in Chapter 8 can be initiated. Second, the training of programmers on System/360 can be started. The Model 30 operates identically with the Model 65 in every way except that it does not have the variety of I/O gear and terminals and it is slower. However, for programmer training, these are not serious limitations. Third, the programming systems outlined in the sections to follow can be experimentally operated, checked out, and modified by the systems programming

group in advance of the time when they will be necessary.

5.1.4. Model 67 Plans

In the first quarter of 1967, the Model 65 CPU will be removed and additional equipment will be installed to make the resulting configuration conform to the schematic in figure 2. In addition to the twin CPU's each with its own preferred pair of high speed memories, additional I/O gear has been added to provide for the growth in services, both on-line and batch, presently anticipated. In addition, a pair of IBM 2846 I/O controllers are added between the channels and the memory bus. These controllers, and the related CPU hardware, were designed for communications-mode time-sharing operation. They provide the dynamic relocation capability thought to be very valuable for this type of operation.

Before the Model 67 with the twin CPUs is installed, communication-mode time-sharing will undergo further evaluation so that the costs and benefits may be evaluated. At the present time, the OCS plans call for the installation of this hardware as a means of raising the availability of the system to those who require remote inquiries.

In any large complex data processing equipment, hardware

components will occasionally malfunction and these malfunctions may require a significant period of isolation and repair. Using the hardware shown on the schematic, isolation switches may be thrown, either automatically or manually, to disconnect a malfunctioning unit and allow the remainder of the system to survive. These switches are an integral portion of the time-sharing hardware option. They allow a properly designed software program to dynamically reconfigure the hardware connections so that the failing unit is isolated. The software may then proceed to re-evaluate priorities for work outstanding and to allocate the remaining processing power to those tasks considered most urgent. This is a limited form of fail-soft operation which will allow all single hardware failures to be absorbed and some triple hardware failures to be absorbed before the system becomes unavailable to all users.

As our computer systems lose their more traditional guise and become a more direct and accessible tool to operating management, availability will be a more critical requirement. A system planned in mid '65 will be installed in mid '67 and should be operating smoothly by Christmas, 1967. This extended development cycle is due to three reasons. First, the hardware and software are not available from the

IBM SYSTEM /360
TWIN MODEL 67 CPU-MULTIPROCESSOR

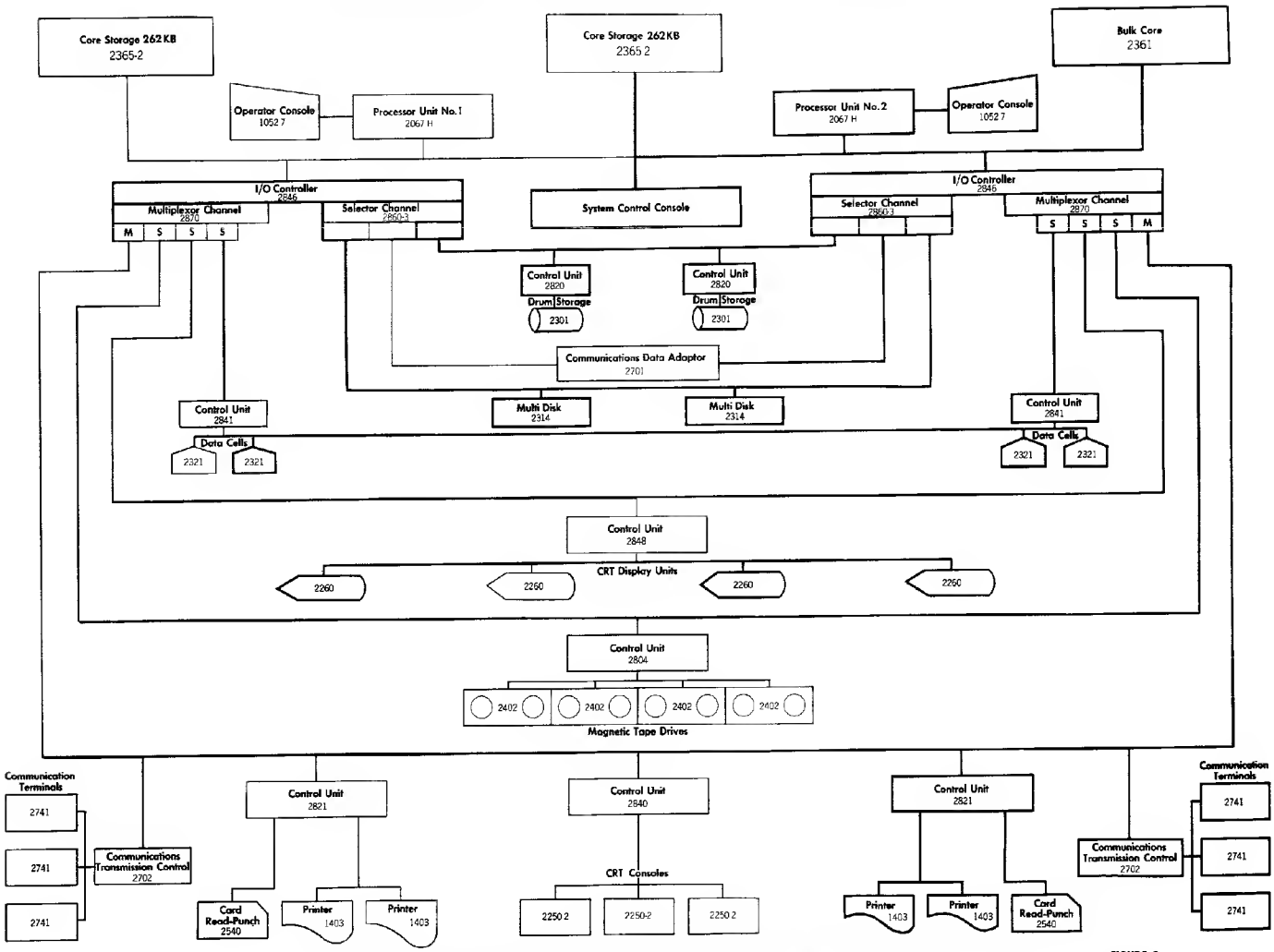


FIGURE 2

vendor until late '66 or early '67. Second, the programming staff is highly compartmented and not totally acquainted with these concepts (they have no experience with this type of operation). Third, even though the hardware, this program, and the staff training were completed and ready, the large data files must be meticulously edited, properly structured, and stored to support such an on-line operation. These files do not now exist in the proper form, and their development is a significant undertaking.

5.2. SYSTEM 360 SOFTWARE

The software provided for System/360 consists of one all-encompassing integrated design implemented in a modular fashion. IBM's distribution agency will provide the software modules requested on magnetic tape. Our systems programmers and the Systems Engineers from IBM will familiarize themselves with the documentation related to the modules requested and, when the tape is received, prepare for a process known as Systems Generations.

Control cards will be prepared and test problems selected. The SE's and systems programmers then will visit IBM's local data center and perform actual SYSGEN. This is a multitask process which results in a customized operating system for our machine. If the newly generated system does not require

hardware which is unavailable at the service center, the system may be tested immediately upon generation. However, if the system requires a unique hardware configuration, it can only be tested at our facility. The resulting operating system consists of a control program and several libraries.

The control program contains only the features selected and the libraries contain language processors to translate the various source languages into load module form.

The control program operates in the supervisor state and performs all I/O, scheduling, interrupt handling, and storage protection. All other programs operate in the problem state. This is true be they applications programs or vendor supplied language processors. Thus, to the control program an application program which determines optimum trajectories appears just like a language processor program which translates FORTRAN IV into load module form.

5.2.1. Language Processors

IBM will provide processors for four different languages. Each language processor has one or more design levels. For example, two FORTRAN processors will be provided. They both operate under the operating system, and they both translate the full language from source to load module form. However, one of these is implemented to accomplish this translation using several overlays, none of which is larger than 10,000

bytes. The other design fits the entire compiler into 200,000 bytes of memory. These offer the user the option of multi-processing, where one processor may be the compiler, or mono-processing to gain speed. Similar compromises are offered for the other source languages.

5.2.1.1. Assembly Language

The assembly program for S/360 operates under Operating System/360 and translates programs in source language form to a form suitable for the Link Editor. The assembly is of more or less traditional design which translates symbolic instructions with mnemonic operation codes into a compressed symbolic form required by the Link Editor. The assembler encompasses the best features from the MACRO forms found in the 7010 Autocoder and the 7090 MAP languages. The expected variety in data representation, address calculation, and applications program sectioning are all provided. The assembler provides the usual program listings and error indications as a by-product of the assembly process. The assembler references no libraries, but translates each module presented on a module by module basis. The output form goes to the Link Editor which resolves inter-module symbols, includes library routines as called, and outputs a relocatable program in load module form suitable for loading into core.

5.2.1.2. FORTRAN

The specs for the FORTRAN provided under Operating System 360 are a superset of the specifications used for the FORTRAN IV compilers now in existence on currently operating equipment. The language and the constructs currently allowed are similarly allowed. However, certain arithmetical differences may result due to the difference in word length between current systems and S/360. Many of the programming restrictions common to current FORTRAN IV have been relaxed in the 360 version. In addition, additional capability has been added in the form of variable attribute control, adjustable array dimensions, and several new codes for formats, I/O lists, spacing, and literals.

5.2.1.3. COBOL

Operating System/360 COBOL is not completely compatible with any of the COBOLS now operating on current equipment. Each of the current COBOLS was designed to effectively exploit one or more current computers. Therefore, they were not completely machine independent. Rather than perpetuate these difficulties, Operating System/360 COBOL cleans up and purifies many of these language constructs, plus providing new language constructs necessary for asynchronous data processing in a multiprogramming environment. An additional program is provided called the COBOL Language

Conversion Program (COBOL LCP) which will translate, where possible, from the constructions presently used in current COBOL programs to the equivalent construction in 360 COBOL. Where translations are impossible, the section of code will be flagged for programmer review.

5.2.1.4. PL/I

In parallel with the development of System/360, a new software design effort was initiated in an attempt to devise one programming language which would be suitable for scientific and engineering calculations, business data processing, and real-time operation. Further, it was decreed that the language should allow and exploit direct access storage devices such as drums and disks, remote terminals, and the dynamic features provided by the control program and the hardware interrupt scheme. To accomplish this assignment, a joint design team was set up consisting of employees of IBM and volunteers provided by the scientific computer users group, SHARE. The first report was published in mid-1964 and has undergone several revisions since then. Superficially, this effort looks like a success and when compilers for the language are available, a detail evaluation will be made.

The adoption of a single programming language, single control program, and single computing system has considerable appeal to those of us who manage a large work force of pro-

grammers working on a variety of assignments in a highly fluid environment. Training is simplified, personnel scheduling and assignment problems are eased, fewer systems programmers are required for trouble shooting and maintenance, and the efficiency of the entire machine room operation is improved. If these advantages can be accomplished with little or no additional costs and if the manufacturer provides language conversion programs to translate from System/360 COBOL and System/360 FORTRAN into PL/I, then the language will undoubtedly be adopted for standard use throughout the Center.

5.2.2. Control Programs

As mentioned above, one integrated control program design was set down and then optional features were provided to support different hardware configurations or modes of operation. One large set of these pertains to Data Management.

Data files can be organized to reside on magnetic tape, disk, or core memory. Furthermore, they may be written once and read many times, constantly undergo update and change, accessed in the same form and sequence as they are updated, or maintained in one form and referenced in yet another sequence and format. These options, combined with the physical specifications for the various disk devices, tapes, and memories, require a series of subprograms to be devised called "access

methods". Additional access methods are sure to come as new devices are developed and made available.

Other control program options concern a choice of operational modes. Data can be batched on a peripheral machine and presented to the central processor as a series of sequential tasks with uniform priority. This, of course, is the traditional mode of operation. Further, data can be presented to a single processor as it becomes available so that the processor may reschedule its outstanding work and adjust its queues between each processing task. Other options are available which allow multiprogramming and two or more processors to perform multiprocessing with fixed or dynamic functional assignments. All of these options are available in the one design. The System Generation function will cause combinations of these modules to be selected to support our operations.

5.2.2.1. Serial Tasking Operations

The first version of operating System/360 to be employed by OCS will be a simple serial tasking, batch-operated system. This will be system generated for the Model 30 configuration and will be used for training system programmers, for verifying the operation for the several language processors, for converting files, and for checking out converted applications programs.

This operating system will also be used to perform SYSGEN for subsequent operating systems, and to check out modifications to the IBM supplied control programs as required by unique conditions existing within OCS. A second version of this serial tasking system will be used for the first several months on the Model 65 after initial installation in the first quarter of '66.

5.2.2.2. Multiprogramming

A multiprogramming operating system will be generated in the third quarter of 1966 for the Model 65 configuration. It will provide for Assembly, FORTRAN, and COBOL source languages. It will be based on the teleprocessing version of OS/360 and will support a limited number of remote consoles. It will encompass access methods for files on magnetic tape, disk and data cell. The preparation of this operating system will not be a trivial task. The manufacturer's offering provides most of the features needed although special modules will need to be prepared for the non-standard analog to digital inputs and the Univac 1004. The accounting provided by the vendor will need to be reviewed so that we may distribute costs to our various users on the basis of usage even though we are operating in a multiprogramming mode. In addition, we must completely review the manufacturer's provisions for

security, and audit trails and accountability. We undoubtedly will find them lacking and, while their provisions will be a useful base, we will be forced to provide additional functional capability to handle our own unique security needs.

5.2.2.3. Remote Retrieval

After the multiprogramming system is operating well and we have become familiar with the hardware and software provided to support remote console operation, it is anticipated that we will have to design one or more additional access methods to allow remote inquiry, in-process interrupt, high priority service, and immediate response for the terminals that we decide to support. It is anticipated that these modifications will take place within the confines of the design of OS/360, but they will be undertakings of significance occasioned by the unique requirements of the Agency.

5.2.2.4. Twin Processor

The IBM software to support the twin Model 67 configuration is now in the process of being specified. As indicated above, the Model 67 is in our plans as the best way to achieve the processing capability we will require in the 1968-72 period. Preliminary specifications for the multiprocessing monitor system are available, and they appear to be in substantial agreement with the Agency's needs. As a minimum, this software will have to be adapted to the Agency configuration

shown previously. In addition, any especial provisions we have incorporated for accounting, security, accountability or retrieval would necessarily have to be incorporated into this software design also. As more details become available on this software, continued study of the specifications will be necessary in order to determine the necessary additions to satisfy the Agency's need.

5.3. ANTICIPATED PROBLEMS

In reviewing the IBM supplied software and in becoming acquainted with the IBM provided hardware, three major problems have been defined which will require study, solution, and management approval before the plan outlined above can be completed. These problems are briefly sketched below.

5.3.1. Secure Files

The IBM hardware has storage protection features which guard against memory access violations due to inappropriate fetching or storing of words outside of a predefined area by an applications program or language processor. Since the control program is the only program authorized to run in the supervisor state, it is the only program which has the ability to alter storage protection keys. Furthermore, it is the only program which may reference I/O files.

A study must be undertaken which reviews these control program features and how they are implemented. The control program itself must be protected from applications programs. The tables within the control program would provide classified information to unauthorized interrogation if they are not private and protected. Whenever programs or hardware malfunction and restart is required, opportunity exists for inadvertant security leaks. Such exposure must be understood and documented to determine if sufficient checks and balances have been performed.

A second portion of the security review and study must report on the security safeguards provided for operation via remote terminals. Questions to be answered are: How do we verify that the person at the terminal is indeed who he says he is? How do we retain the security classification of the physical area in which the terminal is situated? How do we retain the highest classification level for which a communication link is entitled? How do we determine that the person at the console has the need-to-know the information he requests? Does the software provide an algorithm which provides only requested information in the presence of an

established need-to-know up to the level determined by the lowest clearance: com line, physical, or individual? While the above restrictions are both mandatory and desirable under normal circumstances, how can the restrictions be selectively released during periods of dire emergency and who may authorize such a relaxation in the national interest?

5.3.2. Audit Trails and Accountability

The "new wave" in computing is on-line operation. Some of the proponents of this mode of operation have hypothesized that all computing will be on-line in the next few years. Several major obstacles must be overcome before such a system is possible. First, some of our data comes from such widely spread locations that it must first be concentrated before it is entered into the computer. For these data, accuracy is more important than time and the traditional keypunch and verifying process provides high accuracy combined with low cost. In the foreseeable future a good portion of our data will be entered into the machine in this way.

Another facet which will impede the predictions concerns the capabilities of the average trained programmer and his usual work habits. During the process of programming a task, a large job requires access to 20 to 50 different pieces of paper. The current mode of operation spreads these pieces

of paper all over a large desk where they are instantaneously available for ready reference. Single scope displays require another alternative set of work habits: habits not yet developed.

A third reason why our growth may be more leisurely is the motor ability of many of our present programmers. While a large majority of these personnel have had instruction and frequent access to both typewriters and keypunches, they have never achieved much proficiency with either. Thus their entry speed and accuracy will be the source of added expense and some frustration.

These three limitations will be with us even though the current price per user may be brought under control and the capital investment per individual served can be held to a manageable value. Thus, we have four major problems to be solved before remote terminal operation is warmly embraced.

Even though these limitations are removed, yet an additional technical problem exists. Whenever a single file can be accessed by more than one individual or whenever the contents of that file are the result of two or more uncoordinated updates, a severe audit trail and accountability problem will develop. This problem is doubly severe. There is no information

in the published literature which describes any current studies on this topic: planned or completed. Even when and if such studies are available, the problems within the Agency would amplify the difficulties involved, cause a complete review of the solutions, and probably would require some additional features not contemplated elsewhere. At this writing, the problem is as yet unstudied and must be faced soon and solved before the twin Model 67 is installed in first quarter 1967.

5.3.3. Fail-Soft Reconfiguration

Today it is common for many people in the computer field to speak quite glibly about computer based systems which gracefully degrade in the face of hardware outages. The only systems to date that fail-softly are some very expensive military command and control systems which do not handle the breadth of applications we contemplate, nor do they adhere to the budget constraints now impressed upon the Agency. In short, graceful degradation, fail-soft operation, and dynamic reconfigurations have never yet been successfully demonstrated in an industrial environment. The IBM Model 67 is reputed to enjoy these long sought attributes. The software according to preliminary specs is designed to complement the hardware

and allow near 100% availability with a minimum of manual intervention. When the detailed specs for this hardware and software are available, a study effort will be established to meticulously review them and to enumerate the conditions which can be tolerated and allow one computer to automatically survive, the conditions which can be tolerated provided prompt manual action is available, the conditions which cause temporary loss of the facility, and the conditions which cause an extensive period of down time. Hopefully, the latter case will not exist.

Chapter 6.

PERSONNEL TRAINING

6.1. MANAGEMENT TRAINING

Courses which emphasize the characteristics of the IBM 360 Model 67 are planned for management-level personnel. They will cover the operating system, remote terminal usage, scheduling of priorities, etc. Course #1, "Administrative Considerations of a Multi-Programming System" is scheduled for March 1966 for OCS management and supervisory personnel. This is scheduled for a repeat in November 1966. Agency personnel not in OCS but administratively responsible for remote terminal users of OCS hardware will be invited to attend either course. Further courses of this type will be offered on a continuing basis.

6.2. SYSTEM PROGRAMMER TRAINING

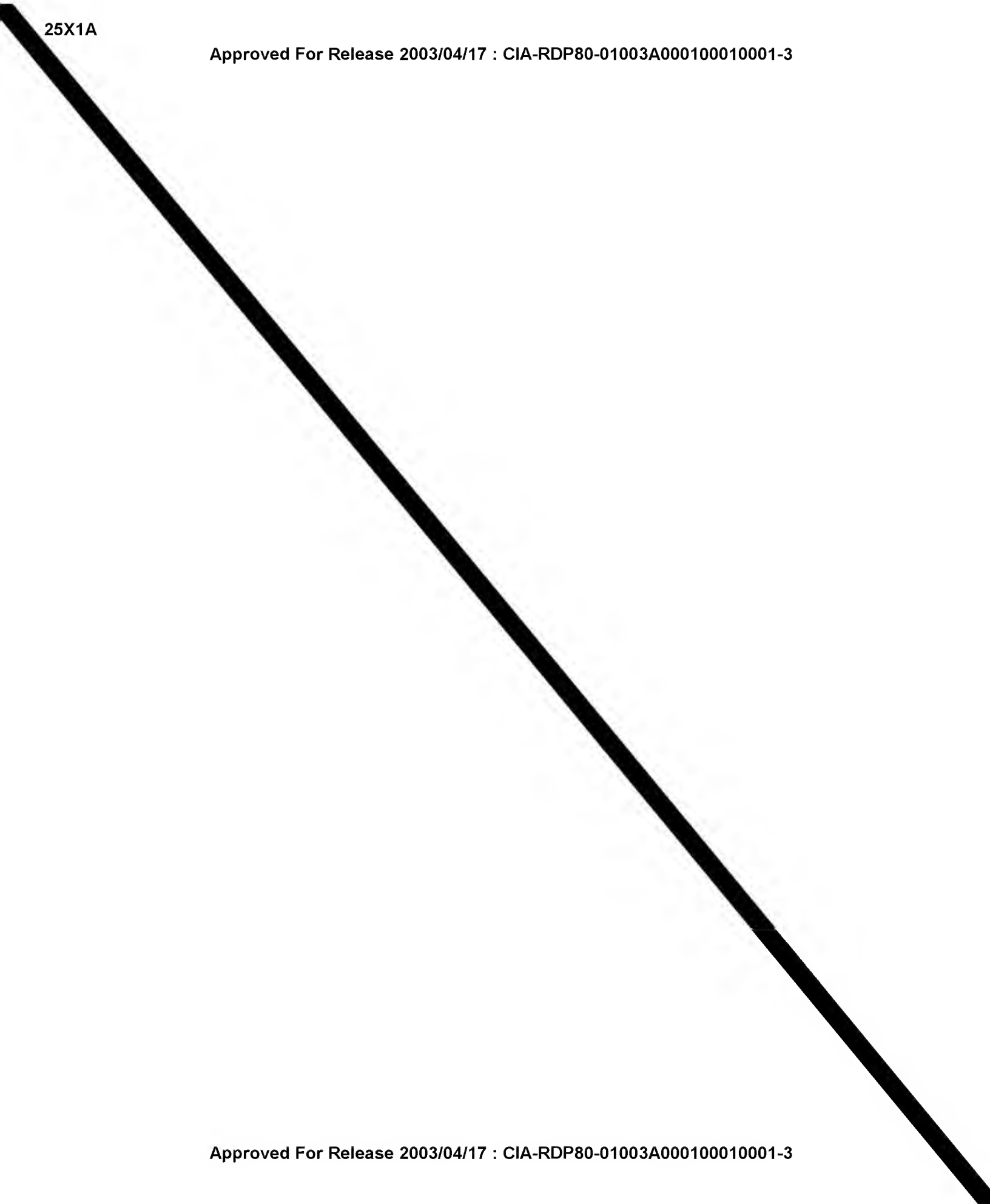
Eight programmers are currently assigned system programming duties. They will be the first personnel to be indoctrinated in System 360 and will acquire broad training in great depth. They will assist in the modification and installation of System 360 software in the Agency. They will act as in-house consultants to the applications programming staff, and they

will perform necessary modifications to the vendor-supplied software to adapt it to the unique needs of the Agency. Most training will be conducted either by the Chief, Technical Staff, or by consultants under his direction. These will be either short 2-4 hour seminars or extensive 2-5 day workshops.

One such workshop has already been held. In this four-day intensive session the design for a multi-utility program was set down. This program will allow the IBM Model 30 to operate several I/O devices concurrently as required. The experience gained in designing and constructing such an interleaved monitor program will be an invaluable base for our further work. The Model 30 will arrive in August 1965 and replace existing 1401 equipment; some of its time will be utilized for advanced system programmer training. In addition, supplementary training will be scheduled at various universities and at the manufacturer's education center as special courses are offered.

6.2.1. Tentative Schedule

The following tentative training schedule has been adopted.



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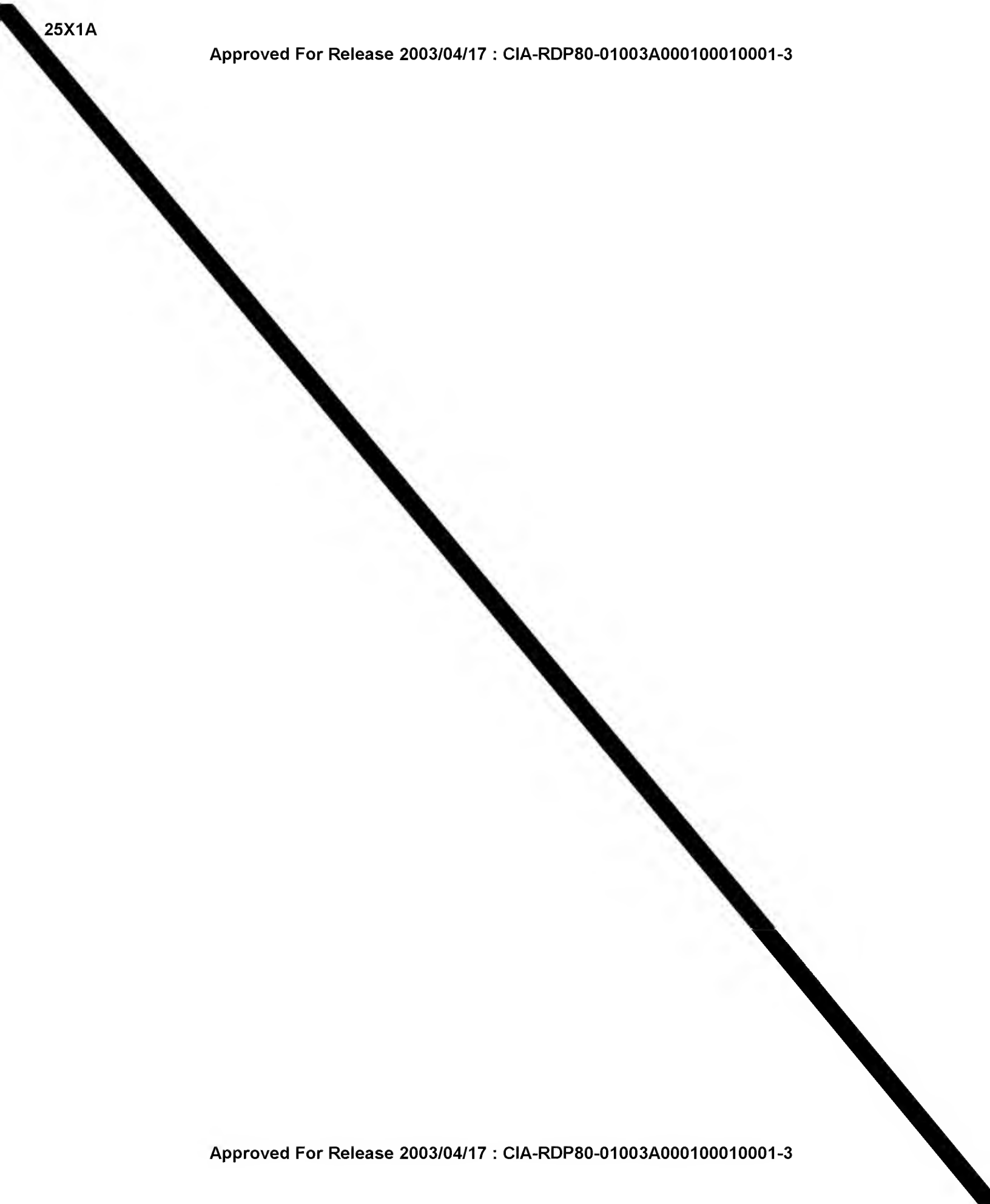
6.3. APPLICATIONS PROGRAMMER TRAINING

A planning effort is now underway to determine the best method for training the applications programmers. Unfortunately, the computer field has yet to adopt a standard glossary. Many of the terms have unique usages private to an individual vendor. Great benefit will result when only one vendor's equipment is installed and only one set of software is used. However, to achieve interchangeability of staff and scheduling flexibility, the existing compartments must be dissolved so that a common vocabulary, training, and expertise is shared by all personnel.

One approach to this is to offer three different series of courses appropriately tuned to the three backgrounds now prevalent in OCS. One course would be offered for programmers skilled in RCA equipment and techniques, one course would be offered for the character-oriented IBM programmers, and the third course would be offered to those experienced on binary-oriented IBM equipment. The first sessions of each of these three courses would be unique to the attendees' background experience. Naturally, the later sessions would be all identical.

In considering such a mode of retraining, considerable attention will be given to measuring the results of the training courses. In an attempt to offer a fair opportunity to all personnel regardless of prior background and in an attempt to objectively measure the quality of the training offered, some attempt will be made to measure the results of the course instruction.

A second approach to training is to exploit the individual courses offered by the vendor. IBM offers a striking variety of reasonably well prepared and adequately documented courses. Until the in-house courses are developed personnel will be scheduled to attend vendor sessions as indicated on the following page. It should be noted that we are still providing training on existing equipment in order to support on-going operations prior to the installation of S/360. The importance of developing excellent training courses to allow the programmers to make the transition from earlier to very sophisticated equipment cannot be overemphasized.



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Chapter 7.

REPROGRAMMING

The computer programs now used within the Center will need review and eventual reprogramming if they are to continue to be of use following the installation of IBM 360 equipment. The S/360 equipment is unique in the computer field in that the instruction decoding within the main frame hardware is implemented using a special technique which involves a read-only storage element. All of the control circuits are controlled by this read-only storage elements to implement the standard instruction set. The original motivation for this design was economy of circuitry and related hardware. However, it is possible to outfit the computer with a second read-only storage element which will cause the S/360 to interpret and decode a second, completely different, set of machine instructions.

The Agency S/360 will be outfitted with a second read-only store causing the S/360 to execute machine language instructions originally intended for a 7090 to be executed, without change, on the System 360. A performance penalty is paid only when this emulator feature is in use. Thus, if a

program's usage is expected to be extensive, the program will still need to be converted. However, through the use of the emulator, it will be possible to stretch out the effort required for program conversion so that the required effort and the available supply of trained manpower more closely approximate each other.

With the exception of the temporary emulator capability for 7090 programs, all existing computer programs will require conversion if they are to be used after the existing hardware is released. In preparation for such conversion activity, several steps may be taken. The programmers will be encouraged to bring their documentation up to date and to prepare current flow charts, program descriptions, table definitions, file specifications, and operators' writeups. Furthermore, special test packages may be prepared which consist of a set of data, a description of that data, a description of the processing the data requires, a set of outputs from the operating program, and annotations on that set of outputs. In addition, the programmers will be supervised so that any special programming techniques or complex sections or code are thoroughly documented and enable the conversion process to proceed with relative ease.

Programs written in machine language are the most difficult to convert. They usually require a manual rewrite of the entire procedure. Programs written in assembly language have some hope of being automatically translated into a language suitable for S/360 provided they do not make special use of unique features available exclusively on current equipment. Programs written totally in a compiler language can be converted automatically to the equivalent compiler language for input to S/360 through the use of a series of programs colloquially known as "SIFT" programs. A SIFT reads the program prepared for current equipment and translates those statements it can to equivalent statements suitable for the new equipment and flags those statements which require manual attention.

Utility programs can be prepared for present equipment which will ease the conversion process by searching out language constructions which are difficult, impossible, or inefficient to translate. Similarly, utility programs can be written for S/360 which will locate and tabulate statements which require further manual attention. An automatically-translated program seldom exploits the capabilities of the new equipment. This statement is even more true when the new equipment offers advanced data management and direct access storage devices. Thus, even when completely automatic translation is possible, the resulting code will need manual review to reduce excessive running times.

7.1. SCIENTIFIC COMPUTING

The scientific programs have been completely reviewed. There will be 47 programs which will be in continuing use after S/360 is installed. Of these, 19 will be completely rewritten by Agency staff members. Agency staff members will sift, review, and check out 28 others. The programming languages currently in use are MAP, FAP, FORTRAN II, and FORTRAN IV. Some of the FAP programs make use of IOCS. It is estimated that 21 man-months will be required to convert the scientific programs assuming we can get the documentation we require from the organizations which originally furnished the programs, such as [redacted] Outside contractual support may be needed to convert programs with inadequate documentation.

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7.2. INTELLIGENCE DATA PROCESSING

The intelligence data processing programs have been completely reviewed. There will be 9 applications which will be in continuing use after S/360 is installed. One of these will use the 7090 emulator, another uses only OCS written general purpose programs. The other 7 applications, and the general purpose programs, will be completely rewritten by Agency staff members. The programming languages they will use will be a combination of 360 Assembly Language and COBOL. It is estimated that 28 man-months will be required to convert the intelligence data processing programs.

7.3. MANAGEMENT DATA PROCESSING

The applications in the management data processing area have been completely reviewed. There will be 7 individual applications in continuing use after S/360 is installed. In addition a single, large-scale Management Information System is being designed which will replace or obsolete the other management data systems currently being processed. These applications will be written using BAL, PL-I, and COBOL. It is estimated that 262 man-months will be required to accomplish this programming effort. To do this will require either an increase in staff personnel or outside contractor support or a combination thereof.

7.4. COMMUNICATIONS OPERATIONS SUPPORT

The supporting programs for communications operations have been completely reviewed. There will be 8 applications in continuing use after S/360 is installed. One of these is in FORTRAN II and may be sifted, reviewed, and checked out. The other four will be rewritten in COBOL. It is estimated that 7 man-months will be required to accomplish this effort.

7.5. STATISTICAL DATA PROCESSING

The programs in the statistical area have been reviewed. There will be 7 applications in continuing use after S/360 is installed. Three of them are in FORTRAN II and may be sifted, reviewed, and re-checked out. The other four will be rewritten in COBOL. It is estimated that 11 man-months will be required to accomplish this effort.

Chapter 8.

FILE CONVERSION

Information files are stored at the present time either in punched-card form, magnetic tape form, or a combination of the two. In addition, the magnetic tapes are prepared for both the RCA equipment and the IBM equipment. The planned life of these files will need evaluation and, if they will be used after the release date of the currently installed hardware, they will require conversion.

8.1. PUNCHED-CARD FILES

Approximately 1,200,000 punched cards are stored by OCS. Many of these contain standard BCD data which can be easily read by the proposed equipment. Others contain information which will be obsolete before the current equipment is released. The remainder are duplicates of magnetic tape files discussed below. From an initial analysis it appears that the conversion of punched card files will be a trivial problem.

8.2. MAGNETIC TAPE FILES

8.2.1. RCA Tapes

The RCA tapes cannot be used on the IBM tape drives. At the present time we have 2,252 RCA tapes in inventory.

From an initial analysis it appears that only 800 of these tapes will be required after the RCA equipment is returned.

An IBM compatible tape drive has been ordered for the RCA 301. After this device has been installed the 301 will be able to read an RCA tape and rewrite the same information on the IBM compatible drive. Following this step, the IBM compatible drive can be entered into the conversion process outlined below. It is estimated that approximately 300 hours of machine time will be required for the translation from RCA to IBM.

8.2.2. IBM Tapes

The IBM file conversion is equally formidable. Several character sets are in use within the facility. The bit structure of alpha-numeric characters must be modified for the S/360 and then translated from seven-track tape to nine-track tape. In addition, some files will require a subsequent sort so that they will again be in the collating sequence of the proposed equipment. The file conversion problem can be broken into eight categories. These categories, and the conversion processes to be followed, are outline below:

Categories of Tape Files	How Converted
A, B	IBM Utility Programs are available. However, OCS has written a multi-

Categories of Tape Files	How Converted
	task tape file conversion program which can convert approximately 30% of these files using the initial Model 30. This same program can run as a background program to other processing, it will be the preferred conversion method.
C	No conversion in initial stages while emulating. Later converted to 9-track by OCS written program, (if file not obsolete).
D	Very probable that file will become obsolete. (Otherwise, use OCS program.)
E	File seldom used, probably program will be emulated with no conversion.
F	Tapes come from special equipment, non-standard and difficult to process. An inefficient conversion is possible using OCS

	written program, however, source equipment should be modified. This will be investigated further.
G	Systems tapes, will not be used on IBM 360, except under emulation. No conversion anticipated.
H	RCA tapes are not compatible with IBM hardware. An IBM compatible tape unit is being installed on the RCA 301. After this hardware compatibility conversion step, tapes will be considered as category A.

8.3. CURRENT INVENTORY

At present, there are 4,017 tapes in active use. An inventory of these tapes, broken down by category, follows:

Type	Description	Category	Number
IBM	Form 1 (non standard min. rec size = 1)	D	29
IBM	Form 2	A	770
IBM	Form 3	A	37
IBM	Form 4	A	255

Type	Description	Category	Number
IBM	FORTRAN Binary (Standard)	B	379
IBM	Binary (No Control Count)	C	11
IBM	Binary (Control record with decrement count)	E	23
IBM	Binary (Control record with counts and other identification information)	C	19
IBM	Binary (Control records with unidentified information, other data is binary integers)	C	7
IBM	Binary stream data with no Gaps	F	3
IBM	Binary, with BCD counts in 24 bit word increments	C	8
IBM	Binary, data with 1 integer per 6 bits records in multiples of 24 bit words.	C	100
IBM	7090 Systems Tapes 1) binary 2) straight core image 3) col binary image 4) row binary image 5) mixed BCD and col binary	G	92
IBM	1401 System Tape Odd Parity BCD, form 1	G	4

Type	Description	Category	Number
IBM	1410 System Tape Odd Parity BCD, form 1	G	28
RCA	BCD, form 4	H	2190
RCA	BCD, form 1	H	62
		TOTAL	4017

8.4. CONVERSION SUMMARY

Of the 4017 tapes in use, 2723 need not be converted. They are either duplicates of tapes which will be converted or files which will be obsolete at the time conversion takes place. As can be seen in the following table, only a few files with nonstandard formats will need to be converted. It is estimated that only two or three man-months of programming effort will be required to prepare programs for this effort. The machine-time hours are summarized below:

	Substantive		Resort		Direct Access		
Cat	(Reels)	Hrs.	(Reels)	Hrs.	(Reels)	Hrs.	Hrs.
A	600	86	90	45	550	110	241
B	300	43			100	20	63
C	30	4					4
F	3	1					1
H	800	114	46	23	750	150	287
						TOTAL	596

Chapter 9.

CONTINUING DEVELOPMENTS

Of the projects now underway, two large efforts will continue to undergo change and evolution during the period when current hardware is released and the new S/360 is installed. Project CHIVE is a large scale document/information retrieval system under evolutionary development in the Agency. The Automated Language Processing system has been under contract for several years and the initial equipment deliveries are scheduled for installation and operation in October 1965.

9.1. DOCUMENT/INFORMATION RETRIEVAL

At the present time, installed computer equipment is being used for exploratory studies. No large production retrieval runs are being made. The period of exploration is drawing to a close and it is predicted that the developmental efforts will use 26 hours of 7090 time per month in third quarter 1965. Starting in early 1966 the project will have matured sufficiently so that the master data base can be constructed. This data base is currently estimated to involve 300,000,000 bytes of information in 1969. Today the file does not exist in automated form. To build such a huge file is an awesome undertaking. It requires hardware of extremely high reliability

with an exceptionally low cost per byte of information stored.

The proposed hardware system provides a Data Cell exclusively for the CHIVE retrieval files. In the interim, magnetic tapes will retain information after the file is read and edited. Starting in 1968, remote console interrogation equipment will also be required on an operational basis. The hardware system proposed, and the software schedules provided, will allow this large file to be interrogated using time-sharing techniques without an appreciable slowing of the background job currently in process.

It should be noted that IBM 360 has a storage device capable of holding the required data volumes required by this project.

Given storage of sufficient volume, it would be possible to dedicate a single isolated computer to the task of waiting for an inquiry, searching the file, and formatting the response. However, it should be noted that this solution would be uneconomical to the Agency since the computing capacity of the dedicated computer would not be available for other purposes. Using the time-sharing techniques proposed, it is estimated that the retrieval query and response processing will total only two hours per day on one model 67 after the system is in full operation.

9.2. LANGUAGE PROCESSING

For several years the Agency has followed developments pioneered by the IBM Corporation in the development of language translation hardware. A key device in this effort is the ALP Processor which is built around a unique read-only photostore memory which holds dictionaries and other lexographic material. The ALP Processor in turn feeds information to a general purpose computer for additional processing.

The special purpose equipment will be delivered and installed in fourth quarter 1965. An IBM 1401 computer will be obtained and dedicated to this development effort. Assuming the equipment and techniques prove out, the 1401 will be returned to the manufacturer on or about September 1966 and the special purpose ALP Processor will be connected to the 360/65 then installed within OCS. Similar time-sharing techniques will be applied to allow the Model 65 to perform commercial and scientific computations whenever its facilities are not required to support the ALP project. When the ALP equipment is inactive, 100 per cent of the Model 65's computational power will be available for other purposes. When the ALP equipment is in use, short sequences (sometimes amounting to only a few milliseconds) of CPU time will be used as required.

It is estimated that the sum total of these little bursts of computation will amount to one half hour per day in the first quarter 1967.

This support makes use of both the multiplexing channel of S/360 and the standard hardware interrupt system. Without these two features, a whole computer would be dedicated while the ALP equipment was in operation.

Chapter 10.

CHANGEOVER SCHEDULE

The plan for transition from the present heterogeneous OCS hardware/software complex to the monolithic system proposed for the Second Quarter 1967 is firm. The transition to this objective acquired several intermediate steps. Even though the schedule is firm, minor modifications will be made in specific features or components or in dates if the production requirements so demand. For example, the plan calls for the IBM 7090 to be replaced with an IBM 360/65 with no time overlap. Of course, this is contingent on the prior thorough testing and 100% compatible performance of the 7090 emulator on the Mod 65.

10.1. INSTALLATION SCHEDULE

The 28 individual events shown on the following schedule are considered management milestones. Naturally, many other intermediate checkpoints will occur between these major milestones. Of particular significance to the Technical Staff are the preparation and/or verification of the four control programs discussed in Section 5.2.2. The successful operation of these programs are prerequisites to the milestones listed below.

Since the various language processors of System 360 are independent of the control programs, the applications work force can proceed to prepare programs; the applications work force can prepare programs in the languages indicated below without fear of having these programs obsoleted by control program changes. In some cases, such as the processing of inquiries from remote consoles, it will be necessary to prepare substitute macros if it is desired to start checkout prior to the availability of certain control program features. When such macros are prepared, it will be possible to program and checkout applications programs which will, to a great extent, be independent of the schedules for control programs. After the control programs and the hardware have been thoroughly checked, the ersatz macros can be replaced by active routines and the console capabilities will be available through the simple process of reassembly.

INSTALLATION SCHEDULE

MILESTONE	TARGET DATE	ACTIVITY
1.	August 1964	FORTRAN II programming discontinued. All new programming in FORTRAN IV.

MILESTONE	TARGET DATE	ACTIVITY
2.	December 1964	1401 AUTOCODER programming discontinued. All new work in 360 assembly language.
3.	July 1965	1410 mainframe converted to 7010.
4.	August 1965	7010 AUTOCODER programming discontinued. All new work in 7010 COBOL.
5.	August 1965	Rearrange machine room in preparation for ALP equipment & Model 30.
6.	September 1965	ALP equipment received from vendor. Model 30 installed.
7.	September 1965	Programming support for 1401 AUTOCODER discontinued.
8.	November 1965	Peripheral 1401 returned to manufacturer. Additional plotter equipment installed.
9.	February 1966	FAP/MAP programming discontinued. All new work in FORTRAN IV or PL/I.
10.	February 1966	7090 COBOL retired. All new work in 360 COBOL or PL/I.
11.	February 1966	Programming support for 7090 COBOL discontinued.
12.	March 1966	S/360 Model 65 received. 7090 returned to manufacturer.
13.	April 1966	7090 FORTRAN IV programming discontinued. New work in 360 FORTRAN or PL/I.

MILESTONE	TARGET DATE	ACTIVITY
14.	April 1966	Beckman A/D equipment received.
15.	July 1966	7010 COBOL programming discontinued. New work in 360 COBOL or PL/I.
16.	July 1966	501 EZCODE programming discontinued. New work in 360 COBOL or PL/I.
17.	July 1966	RCA 301 Code programming discontinued. New work in 360 COBOL or PL/I.
18.	September 1966	ALP on-line to Model 65. ALP 1401 returned to manufacturer.
19.	October 1966	7010 AUTOCODER Programs converted to PL/I.
20.	November 1966	7010 COBOL Programs converted to 360 COBOL or PL/I.
21.	November 1966	7010 returned to the manufacturer.
22.	December 1966	7090 FORTRAN II programs converted to 360 FORTRAN or PL/I.
23.	January 1967	7090 FORTRAN IV programs converted to 360 FORTRAN or PL/I.
24.	February 1967	7090 FAP/MAP programs converted to PL/I.
25.	March 1967	Twin Model 67's received. Models 30 and 65 returned to manufacturer.
26.	May 1967	RCA 301 returned to manufacturer.

MILESTONE	TARGET DATE	ACTIVITY
27.	May 1967	RCA 501 declared surplus.
28.	May 1967	RCA 301/501 programming discontinued.

10.2 PHYSICAL ARRANGEMENTS

To accomplish the hardware transformations indicated in the previous section, eleven hardware events will take place. Although some crowding will take place and temporary operational dislocations will result, the hardware events planned can take place completely within the confines of the present CIA Computer Center. As shown on the following table, the air conditioning and KVA loads will vary throughout this process. Based on available preliminary information, no additional air conditioning or power capacity will be required although minor changes and adjustments will be necessary to provide cooling where the heat is generated and receptacles where the power is required.

	Event Date	Event	Air Condit. BTU/Hr	Power KVA
1.	Jun 65	None (presently Installed Computers)	349,000	135
2.	Jul 65	Convert IBM 1410 System to IBM 7010 System and provide space for ALP System.	354,000	138
3.	Aug 65	Move IBM 1401 System, Cal-Comp Plotter, and IBM 7090 for IBM 360/30 installation	354,000	138
4.	Sep 65	Install IBM/360/30 and ALP	478,000	187
5.	Nov 65	Remove IBM 1401 System and Temporary Installation; Install Benson-Lehner Plotter.	411,000	158
6.	Mar 65	Remove IBM 7090; Install 360/65	560,000	218
7.	Apr 66	Install Beckman A/D System	585,000	228
8.	Nov 66	Connect ALP to 360/65; Remove IBM 7010 System	489,000	182
9.	Mar 67	Install IBM 360/67 System Remove IBM 360/30	700,000	259
10.	May 67	Remove RCA 301 System	675,000	251
11.	May 67	Remove RCA 501 System	612,000	229

Chapter 11.

BIBLIOGRAPHY

During the course of this study, several supporting investigations and studies were performed. These are in the OCS administrative files for the use of interested parties. They are described below.

11.1. ADVANCED (THIRD GENERATION) HARDWARE AND SOFTWARE TECHNOLOGY

Describes the terminology, hardware and software considerations necessary in a multi-time-sharing system. Discusses I/O and computing methods, concepts of remote user terminals, fail soft, fail safe, and memory protect features of new technology. Third generation micro-electronics, random access hardware, bulk core, and CRT display systems are discussed. A general discussion of methods and considerations in reprogramming for a new computer system is given.

11.2. COMPETITIVE HARDWARE EVALUATION

Computes the relative efficiency of competitive computer systems. Introduces, very briefly, 16 separate computer systems and evaluates the efficiency of these systems against the IBM 7094. Provides efficiency factors based on cycle time, add time, and cost to arrive at relative cost-efficiency

factors. Comparative computer hours required to accomplish two different work loads are presented for 24 old and new computer systems.

11.3 PHYSICAL PLAN FOR COMPUTER EQUIPMENT

Physical plan for hardware installation describes the floor plan, power, and air conditioning required for the central computer room from its current configuration until the final installation of the multi-processor IBM 360 installation in 1967. Considers all known hardware additions, substitutions and deletions during this time period.

11.4 CURRENT UTILIZATION AND COSTS

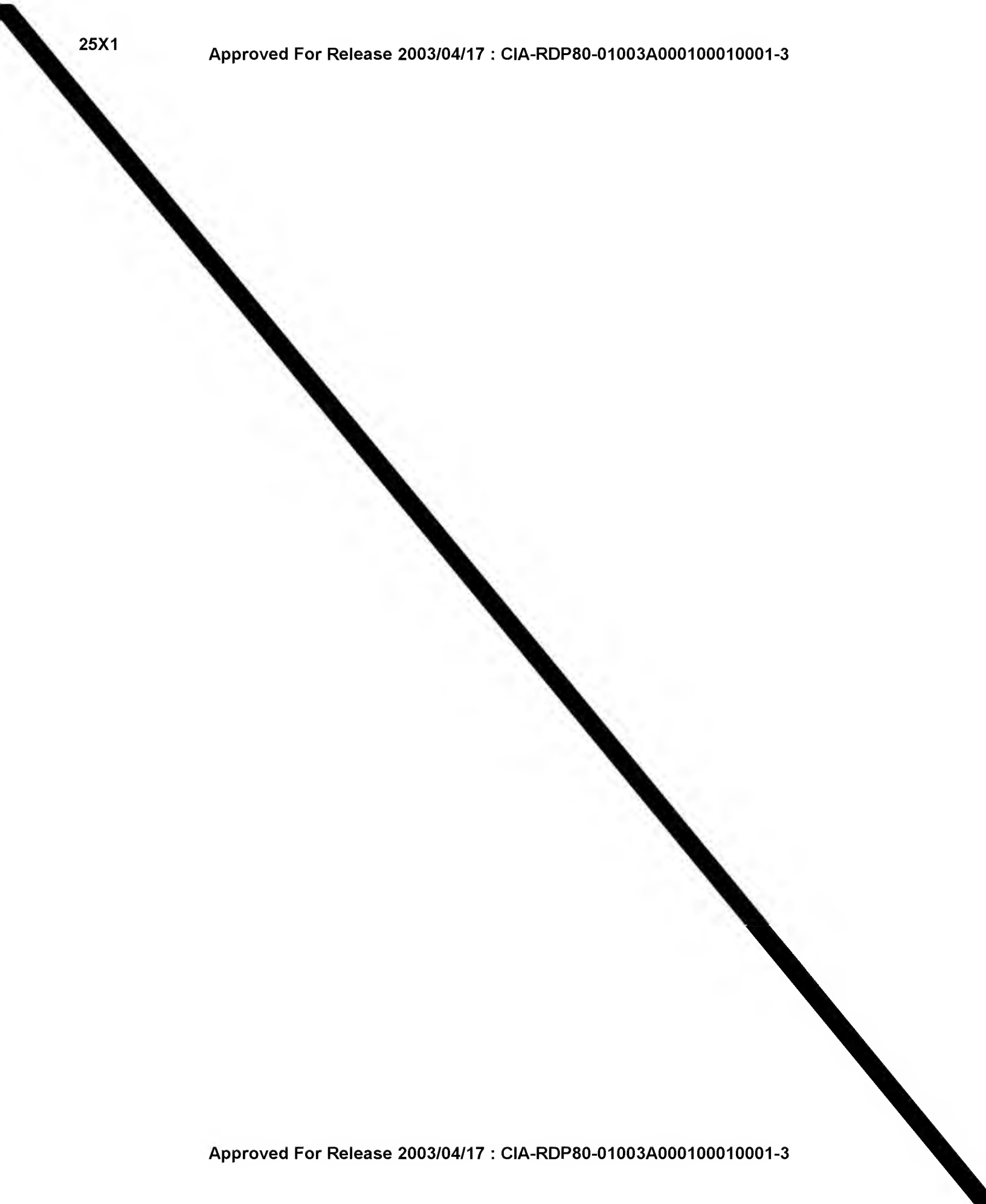
Study of the OCS computer center's hardware utilization and costs. Gives data on computer use time for various agency "customers" and graphs total utilization by computer system.

11.5 TRAINING REQUIREMENTS

Provides individual training schedules required to prepare all programmers and operators for the IBM 360 system. Some 20 courses are listed. Schedules list courses to be taken by each individual by calendar year quarters.

11.6 RENT VERSUS PURCHASE CONSIDERATIONS

The rent and purchase cost factors are in terms of the estimated retention period for each hardware component during the evolution of advanced computer system.



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